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ABSTRACT

The manual is one of a series written especially for the Photographer's Mate rating in the United States Navy; its contents are based directly on the qualifications for advancement to the first class petty officer and chief petty officer rates. The first three chapters of the manual cover topics related specifically to the Navy: photographer's mate rating, organization and administration, and supply and accounting procedures. Five of the remaining 10 chapters acquaint the learner with the photographic techniques and equipment required by Naval operations: chapter 4, which teaches techniques for portraiture, emphasizing shipboard portraits, and chapters 8-11, deal with aerial photography: cameras, accessories, control systems, and missions. The final chapter treats underwater photography. The remaining four chapters, dealing with quality assurance, machine processing, and motion picture equipment and techniques, offer more generally applicable information, principles, and methodology, although the special needs of the Navy are reflected in such subtopics as camouflage detection films. The manual is heavily illustrated with photographs and line drawings of camera and other photographic equipment. (AJ)

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PHOTOGRAPHER'S MATE 1 & C

NAVAL EDUCATION & TRAINING COMMAND

RATE TRAINING MANUAL NAVEDTRA 10375-C

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PREFACE

This Rate Training Manual is one of a series written especially for the Photographer's Mate rating. Its contents are based directly on the qualifications for advancement in the PH rating. This manual is to be used as a source of information by Regular Navy petty officers as well as by Naval Reserve personnel in qualifying for advancement to the first class petty officer and chief petty officer rates.

The qualifications used as minimum requirement guidelines in the preparation of this manual are to be found in the Manual of Qualifications for Advancement, NavPers 18068 (Series). The Photographer's Mate studying for advancement should insure that he is using the latest edition of NavPers 18068 as his reference to the military and professional qualifications for the rate to which he is to advance.

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Credit is also afforded the Eastman Kodak Company, Rochester, N.Y., for their cooperation in permitting use of their technical data covering many aspects of color photography, found in chapter 5 of this manual.

Credit is also extended to the Arriflex Company of America, Woodside, N.Y. for photographs of their equipment and data used in chapter 12 of this manual.

The Photo-Lab-Index (NavWeps 10-1-510), published by Morgan and Morgan, New York, N.Y., is cited as a reference publication throughout this manual.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CREDITS

The Navy is indebted to the Eastman Kodak Company, Rochester, New York, for permission to reproduce the copyrighted materials that appear in chapter 5 of this manual, starting on pages as indicated:

Page 117 Extracted from Kodak Ektacolor Internegative Film Data Sheet, KP52161c.

Page 124 Extracted from "Printing Color Negatives, Kodak Color Data Book E-66, Third Edition–Third Printing, 1966."

Page 125 Extracted from "Printing Color Negatives, Kodak Color Data Book E-66, Third Edition–Third Printing, 1966."

Page 126 Extracted from "Printing Color Negatives, Kodak Color Data Book E-66, Third Edition–Third Printing, 1966."

Page 134 Extracted from "Errors in Processing Kodak Ektacolor Professional Paper, Kodak Sales Service Pamphlet No. E-51."

The Navy is indebted to the Arriflex Company of America, Woodside, New York, for photographs of the Arriflex 16mm motion picture cameras, models M/B and S/B, appearing in chapter 12.

CHAPTER 1

PHOTOGRAPHER'S MATE RATING

This Rate Training Manual is designed to aid the PH2 to advance to PH1 and the PH1 to advance to PHC. It is based primarily on the professional requirements or qualifications for PH1 and PHC as specified in the Manual of Qualifications for Advancement, NavPers 18068-C. In preparing for the advancement examination, this manual should be studied in conjunction with Military Requirements for Petty Officers 1 and C, NavTra 10057 Series, which covers the military requirements for all senior petty officers.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings: general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

PH RATING

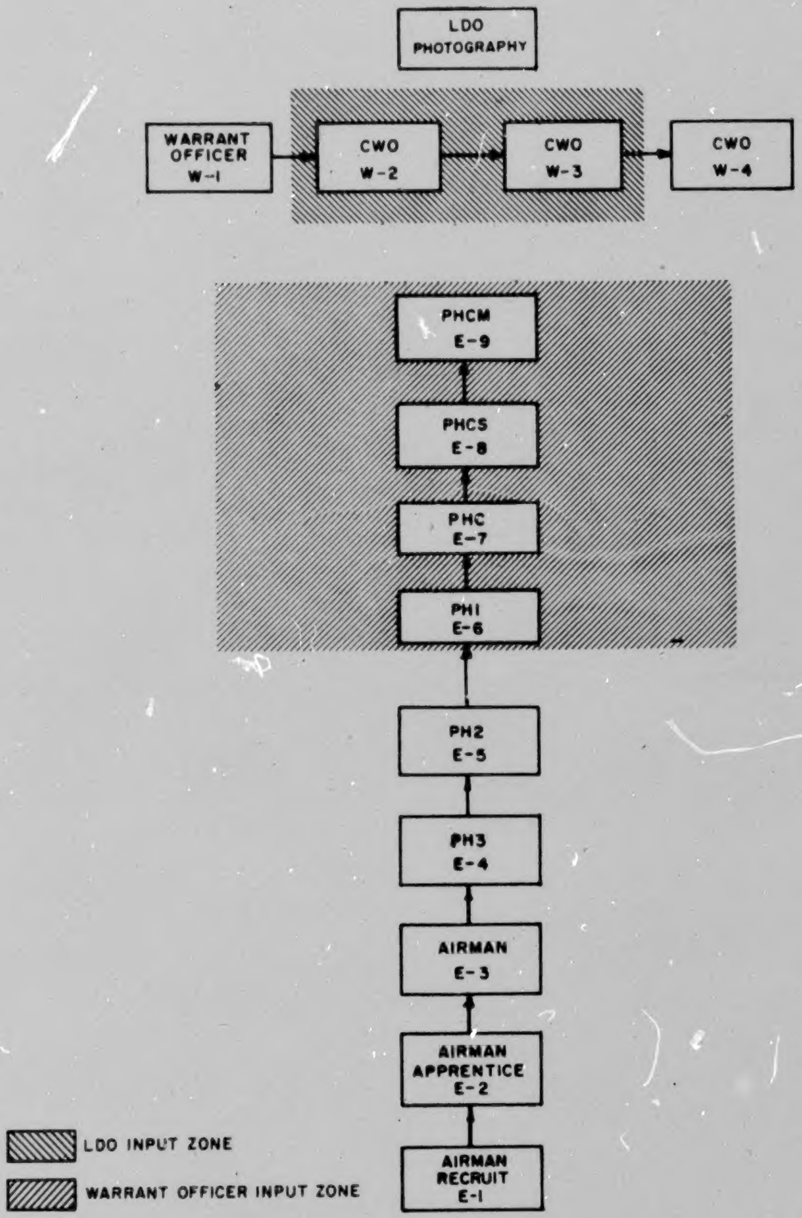
The PH rating is a general rating and is contained within the Navy Occupational Group IX, Aviation.

The Manual of Qualifications for Advancement, NavPers 18068 Series, directs that the PH shall be responsible for the accomplishment of photographic work required by the naval service; recording actual and simulated battle operations; making pictorial records of historical and newsworthy events aboard ship and ashore; exposing and processing light-sensitive negative and positive material; arranging, composing, and illuminating photographic subjects; making finished prints, mosaics, and strip photographs; inspecting and maintaining cameras and camera control equipment, laboratory equipment, and related photographic equipment and accessories; and maintaining associated photographic files, records, and supplies.

Figure 1-1 illustrates the path of advancement from Recruit to Master Chief Photographer's Mate, Warrant Officer, and Limited Duty Officer.

Shaded areas in figure 1-1 indicate career stages from which selected petty officers may advance to Warrant Officer and Limited Duty Officer.

The PH1 must be able to select color compensation filters and make color prints; spot prints and opaque negatives; perform intermediate and major inspections of airborne photographic systems; check shutter synchronization in ground still cameras to determine if adjustments are required; check laboratory electronic interval controls for correct operation to determine if corrective action is required; use the NavAir Publication Index, NavSub Publication 2002, to locate, identify, and obtain


LDO
PHOTOGRAPHY
WARRANT
OFFICER
W-1
CWO
W-2
CWO
W-3
CWO
W-4
PHCM
E-9
PHCS
E-8
PHC
E-7
PH1
E-6
PH2
E-5
PH3
E-4
AIRMAN
E-3
AIRMAN
APPRENTICE
E-2
AIRMAN
RECRUIT
E-1
LDO INPUT ZONE
WARRANT OFFICER INPUT ZONE

PH.1

Figure 1-1.—Paths of advancement.

technical publications, directives, and manuals; identify photographic parts and materials by nomenclature and stock number and prepare supply requisitions; conduct inventories and maintain custody records; establish negative and positive print files and insure security; and prepare periodic reports of photographic operations and equipment.

In addition to the qualifications set forth above for the PH1, the PHC must also be able to inspect photographic work areas and equipment for potentially hazardous conditions and practices and take appropriate action; organize and administer a program of safety instruction applicable to photographic equipment and facilities; interpret instructions and directives on safety precautions to identify those applicable to photographic work areas and equipment; establish safeguards, procedures, and standards to assure compliance by the personnel supervised; determine types of cameras and associated equipment and materials necessary for any type of photographic assignment; review completed laboratory work to insure quality control; analyze malfunctions in photographic equipment and determine corrective action; evaluate performance of overhauled or newly installed photographic equipment; supervise maintenance of photographic equipment; initiate surveys of accountable photographic equipment; and prepare for advanced base or forward area operation by estimating photographic equipment, material, and personnel required.

Sea duty billets for the PH1 and PHC may be aboard aircraft carriers of all types, tenders, or command ships. Reconnaissance photographic squadrons, as well as utility and patrol squadrons, demand the services of PH's. Overseas naval stations and naval air stations claim the services of many PH's, as do billets with staffs and joint staffs. There are also combat camera groups and amphibious activities to which the PH's are assigned.

Shore duty for the PH1 and PHC is routinely assigned to practically all naval shore activities regardless of their individual size, as long as they have a need for photography. The Naval Photographic Center has a large staff of Photographer's Mates who do everything from making full length motion pictures, on completely equipped sound stages, to working in almost every conceivable matter pertaining to photography.

There are numerous billet possibilities at the Naval Air Technical Training Unit, NAS, Pensacola, Florida, for senior petty officers. These billets involve instructor duty in the Classes A, B, and C schools located there. Generally, the best qualified senior petty officers are those who have had the most experience in supervision and teaching of the men under them. The schools at NATTU, Pensacola, offer the senior petty officer an outstanding opportunity to vitalize his various abilities in leadership. He comes by this opportunity through instruction and supervision of the students, and through his constant study to maintain his curricula abreast of rapidly changing photographic methods, techniques, and systems.

Chief Photographer's Mates are eligible for assignment to the Naval Education and Training Program Development Center, Pensacola, Florida, as Technical Writers and Item Writers. Their duties as Technical Writers include assisting in the preparation and revision of the Rate Training Manuals and Nonresident Career Courses for the PH rating. Their duties as Item Writers include assisting in the preparation of the Navy-wide advancement examinations for enlisted personnel in the PH rating.

LEADERSHIP

The PHI and PHC must assume proportionately greater responsibilities on reaching senior petty officer status. They are called on to do a great deal more supervisory and administrative work than before. They must be ready for this type of work.

Realizing that few people are "born leaders," the Navy promulgated the Naval Leadership Program. This program has fostered a wealth of leadership material specifically written for the senior petty officer. An honest study of this material will make you aware of the leadership responsibilities you have accumulated, and will definitely aid you in developing your leadership qualitites. You will undoubtedly find that some of your leadership traits are more strongly developed than others after a little self-evaluation. This is your cue to work very hard on your weaker ones in order to bring as many of your leadership traits as possible up to par, a high par at that. Your ultimate success as a real leader is calculated to a great extent by your ability to inspire others to learn and perform. You may have learned in your earlier petty officer days that teaching by personal example was one of the best teaching tools. It should be even more so now that you have grown in knowledge, understanding, and experience. Treat personal example as one of your best teaching methods.

ADVANCEMENT

By this time, you are probably well aware of the personal advantages of advancement—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a person who can supervise, lead, and train others and second, you become more valuable as a technical specialist and thus make far-reaching contributions to the entire Navy.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement. However, you may find it helpful to read the following sections. The Navy does not stand still. Things change all the time, and it is possible that some of the requirements have changed since the last time you went up for advancement. Furthermore, you will be responsible for training others for advancement; therefore, you will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement, a person must:

1. Have a certain amout of time in grade.
2. Complete the required military and professional training manuals.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavTra 1414/1.
4. Be recommended by his commanding officer.
5. Demonstrate his KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement, but it does not guarantee his advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and quotas enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

Preparation for advancement includes studying the qualifications, working on the practical factors, studying the required Rate Training Manuals, and studying any other material that may be specified. To prepare yourself for advancement, or to help others prepare for advancement, you will need to be familiar with (1) the "Quals" Manual, (2) the Record of Practical Factors, NavTra 1414/1, (3) a NavTra publication called Bibliography for Advancement Study, NavTra 10052 (Series), and (4) Rate Training Manuals. The following sections describe these materials and give some information on how to use them to the best advantage.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all ratings rather than to any one rating alone. Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Rate Training Manuals are revised. By the time you are studying this training manual, the "quals" may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.

2. Each "qual" has a designated rate level–chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels.

3. The written examinations for advancement will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

Record of Practical Factors

A special form known as the Record of Practical Factors, NavTra 1414/1, is used to record the satisfactory performance of the practical factors. This form lists all military and all professional practical factors. Whenever a person demonstrates his ability to perform a practical factor, appropriate entries must be made in the DATE and INITIAL columns. As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new forms of NavTra 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rate, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually inserted in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-3 through E-8 for his personal record and guidance.

NavTra 10052

Bibliography for Advancement Study NavTra 10052 (Series), is a very important publication for anyone preparing for advancement. This publication lists required and recommended Rate Training Manuals and other referrence material to be used by personnel working for advancement. NavTra 10052 (Series) is revised and issued once each year by the Naval Training Support Command.

Each revised edition is identified by a letter following the NavTra number. When using this publication, be SURE you have the most recent edition.

The required and recommended references are listed by rate level in NavTra 10052 (Series). It is important to remember that you are responsible for all references at lower rate levels, as well as those listed for the rate to which you are seeking advancement.

Rate Training Manuals that are marked with an asterisk (*) in NavTra 10052 (Series) are MANDATORY at the indicated rate levels. A mandatory training manual may be completed by (1) passing the appropriate Non-Resident Career Course that is based on the mandatory training manual; (2) passing locally prepared tests based on the information given in the mandatory training manual; or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement, do not overlook the section of NavTra 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance. Also, make sure that personnel working for advancement study the references which are listed as recommended but not mandatory in NavTra 10052 (Series). It is important to remember that ALL references listed in NavTra 10052 (Series) may be used as source material for the written examinations, at the appropriate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Manuals (such as this one) are prepared for most enlisted rates and ratings, giving information that is directly related to the professional qualifications for advancement. Basic manuals give information that applies to more than one rate and rating.

Rate Training Manuals are revised from time to time to bring them up to date. The revision of a Rate Training Manual is identified by a letter following the NavTra number. You can tell whether a Rate Training Manual is the latest edition by checking the NavTra number (and the letter following the number) in the most recent edition of List of Training Manuals and Correspondence Courses, NavTra 10061 (Series).

Rate Training Manuals are designed for the special purpose of helping naval personnel prepare for advancement. By this time, you have probably developed you own way of studying these manuals. Some of the personnel you train, however, may need guidance in the use of Rate Training Manuals. Although there is no single "best" way to study a training manual, the following suggestions have proved useful for many people:

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual primarily to meet these "quals."
2. Before you begin to study any part of the training manual intensively, get acquainted with the entire manual. Read the preface and the table of contents. Check through the index. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.
3. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the manual.
4. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.
5. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

6. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Or is this something new and different? How does this information relate to the qualifications for advancement?

7. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Without looking at the training manual, write down the main ideas you have learned from studying this unit. Do not just quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

8. Use Non-Resident Career Courses whenever you can. The courses are based on Rate Training Manuals or other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing a Non-Resident Career Course based on the training manual. You will probably find it helpful to take other non-resident career courses, as well as those based on mandatory training manuals. Taking a non-resident career course helps you to master the information given in the training manual, and also gives you an idea of how much you have learned.

INCREASED RESPONSIBILITIES

When you assumed the duties of a PO3, you begin to accept a certain amount of responsibility for the work of others. With each advancement, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rate. When you advance to PO1 or CPO, you will find a noticeable increase in your responsibilities for leadership, supervision, training working with others, and keeping up with new developments.

As your responsibilities increase, your ability to communicate clearly and effectively must also increase. The simplest and most direct means of communication is a common language. The basic requirement for effective communication is therefore a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communication is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

Leadership and Supervision

As a PO1 or CPO, you will be regarded as a leader and supervisor. Both officers and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical, on-the-job language that can be understood and followed by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their jobs correctly. At the same time, you must be able to explain to officers any important problems or needs of enlisted personnel. In all military and professional matters, your responsibilities will extend both upward and downward.

Along with your increased responsibilities, you will also have increased authority. Officers and petty officers have POSITIONAL authority—that is, their authority over others lies in their positions. If your CO is relieved, for example, he no longer has the degree of authority over you that he had while he was your CO, although he still retains the military authority that all seniors have over subordinates. As a PO1, you will have some degree of positional authority; as a CPO, you will have even more. When exercising your authority, remember that it is positional—it is the rate you have, rather than the person you are, that gives you this authority.

A Petty Officer conscientiously and proudly exercises his authority to carry out the responsibilities he is given. He takes a personal interest in the success of both sides of the chain of command . . . authority and responsibility. For it is true that the Petty Officer who does not seek out and accept responsibility, loses his authority and then the responsibility he thinks he deserves. He must be sure, by his example and by his instruction, that the Petty Officers under him also accept responsibility. In short, he must be the leader his title—Petty Officer—says he is.

Training

As a PO1 or CPO, you will have regular and continuing responsibilities for training others. Even if you are lucky enough to have a group of subordinates who are all highly skilled and well trained, you will still find that training is necessary. For example, you will always be responsible for training lower rated personnel for advancement. Also, some of your best workers may be transferred; and inexperienced or poorly trained personnel may be assigned to you. A particular job may call for skills that none of your personnel have. These and similar problems require that you be a training specialist—one who can conduct formal and informal training programs to qualify personnel for advancement, and one who can train individuals and groups in the effective execution of assigned tasks.

An expanded source of in-depth training is available at the Naval Schools of Photography, NATTU, NAS Pensacola. NATTU offers, at the PH(B) School level, six blocks of training, including Sensitometry, Color Photography, Management, Studio Photography, Public Affairs Photography, and Motion Pictures. This block training can be accomplished in from 1 to 5 weeks while a man is on TAD status. Even though the full PH(B) School is available, block training may result in considerable savings, especially in the instance that an activity requires a man immediately with in-depth training in a specific specialty area. Convening dates are available upon request from NATTU, Director of Training.

Much of your training, however, will be on-the-job training, whereby you train either your subordinates or yourself on the basis of information in this manual.

In using this training manual, study the information from two points of view. First, what do you yourself need to learn from it? And second, how would you go about teaching this information to others?

Training goes on all the time. Every time a person does a particular piece of work, some learning is taking place. As a supervisor and as a training expert, one of your biggest jobs is to see that your personnel learn the RIGHT things about each job so that they will not form bad work habits. An error that is repeated a few times is well on its way to becoming a bad habit. You will have to learn the difference between oversupervising and not supervising enough. No one can do his best work with a supervisor constantly supervising. On the other hand, you cannot turn an entire job over to an inexperienced person and expect him to do it correctly without any help or supervision.

In training lower rated personnel, emphasize the importance of learning and using correct terminology. A command of the technical languages of your occupational field enables you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with his work is definitely at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the examinations for advancement. To train others in the correct use of technical terms, you will need to be very careful in your own use of words. Use correct terminology and insist that personnel you are supervising use it too.

You will find the Record of Practical Factors, NavTra 1414/1, a useful guide in planning and carrying out training programs. From this record, you can tell which practical factors have been checked off and which ones have not yet been done. Use this information to plan a training program that will fit the needs of the personnel you are training.

On-the-job training is usually controlled through daily and weekly work assignments. When you are working on a tight schedule, you will generally want to assign each person to the part of the job that you know he can do best. In the long run, however, you will gain more by assigning personnel to a variety of jobs so that each person can acquire broad experience. By giving people a chance to do carefully supervised work in areas in which they are relatively inexperienced, you will increase the range of skills of each person and thus improve the flexibility of your working group.

Working With Others

As you advance to PO1 or CPO, you will find that many of your plans and decisions affect a large number of people, some of whom are not even in your own occupational field. It becomes increasingly important, therefore, for you to understand the duties and responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of others, and plan your work so that it will fit into the overall mission of the organization.

Keeping Up With New Developments

Practically everything in the Navy–policies, procedures, publications, equipment, systems–is subject to change and development. As a PO1 or CPO, you must keep yourself informed about changes and new developments that affect you or your work in any way.

Some changes will be called directly to your attention, but others will be harder to find. Try to develop a special kind of alertness for new information. When you hear about anything new in the Navy, find out whether there is any way in which it might affect your work. If so, find out more about it.

SOURCES OF INFORMATION

As a PO1 or CPO, you must have an extensive knowledge of the references to consult for accurate, authoritative, up-to-date information on all subjects related to the military and professional requirements for advancement.

Publications mentioned in this chapter are subject to change or revision from time to time–some at regular intervals, others as the need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure that you have a copy in which all official changes have been made.

A list of training manuals and publications that will be helpful as references and for additional study in preparing for advancement is included in the reading list at the beginning of this text. Additional training manuals that are applicable are available through your educational services officer.

In addition to training manuals and publications, training films furnish a valuable source of supplementary information. Films that may be helpful are listed in the U.S. Navy Film Catalog, NavAir 10-0-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief is not the end of the line as far as advancement is concerned. Proficiency pay, advancement to Senior (E-8) and Master (E-9) Chief, and advancement to Warrant Officer and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The Career Compensation Act of 1949, as amended, provides for the award of proficiency pay to designated enlisted personnel who possess special proficiency in a military skill. Proficiency pay is given in addition to regular pay and allowances and any special or incentive pay to which you are entitled. Certain enlisted personnel in pay grades E-4 through E-9 are eligible for proficiency pay. Proficiency pay is allocated by ratings and NEC's, with most awards being given in the ratings and NEC's which are designated as critical. The eligibility requirements for proficiency pay are subject to change. In general, however, you must be recommended by your commanding officer, have a certain length of time on continuous active duty, and be career designated.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief petty officers may qualify for the advanced grades of Senior and Master Chief.

These advanced grades provide for substantial increases in pay, together with increased responsibilities and additional prestige. The requirements for advancement to Senior and Master Chief are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, and a sufficiently high mark on the Navy-wide examination. The final selection for Senior and Master Chief is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Chief Petty Officers.

The Bibliography for Advancement Study, NavTra 10052 (Series), contains a list of study references which may be used to study for both military and professional requirements.

The satisfactory completion of the nonresident career course titled Military Requirements for Senior and Master Chief Petty Officer, NavTra 91209, is mandatory for advancement to E-8 and E-9.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program provides opportunity for advancement to warrant rank for enlisted personnel.

The LDO program provides a path of advancement to commissioned officer. LDO's are limited, as are warrants, in their duty, to the broad technical fields associated with their former rating.

If interested in becoming a warrant of commissioned officer, ask your educational services officer for the latest requirements that apply to your particular case.

CHAPTER 2

ORGANIZATION AND ADMINISTRATION

In order to efficiently operate a Navy photographic laboratory or unit, the Photographer's Mate First Class and the Chief Photographer's Mate should be acquainted with the organization and administration of naval photography.

Naval photography, as used in this chapter, means the administration and use of photography and photographic intelligence within the Naval Establishment. The term Naval Establishment, in turn, means the naval sea, air, and ground forces; vessels of war, aircraft, auxiliary craft, auxiliary activities, and the personnel who man them; and the naval agencies necessary to support and maintain the naval forces and administer the Navy as a whole.

The U.S. Navy Manual of Naval Photography, OpNav Instruction 3150.6 Series, governs the administration of photographic laboratories. It contains information concerning organization, administration, policies, and instructions governing the use of photography in the naval service. The Senior Photographer's Mate should keep himself thoroughly familiar with the contents of this manual and its latest revisions. Certain portions of the material in this manual are discussed briefly in the following pages.

ADMINISTRATION OF NAVAL PHOTOGRAPHY

The responsibility for overall administration of Naval Photography is vested in the Chief of Naval Operations, Navy Department. However, at the local level, photography is a command function intended to serve the needs of the local commander. Special programs, policy guidance, and required procedures are directed by the Chief of Naval Operations as necessary. Guidance and direction of effort in assigned areas of responsibility are provided by the Commander, Naval Air Systems Command, who is designated as the principal Naval Technical Assistant, and also by other authorities of the Navy Department within specialized areas.

Under the Chief of Naval Operations, the Chief, Systems Branch of Naval Reconnaissance Center, (OP-3R3) and his assistant, (OP-03R32), are responsible for the operational readiness of the aerial reconnaissance program and related functions, and directs the naval photographic programs.

The Director, Photographic Division, under the Chief, Naval Air Systems Command, is responsible for the following specified duties:

1. Establishing, coordinating, reviewing, and revising specifications and standards for photographic materials used by the Department of the Navy.
2. Planning, initiating, and directing photographic research, design, maintenance and repair of photographic equipment.
3. Exercises management control of those commands and organizations established as separate activities of the shore establishment, primarily for research and development photography.
4. Distributes photographic equipment to the Department of the Navy.

When the operation of a photographic facility in a naval activity has been authorized by the Chief of Naval Operations, it is the responsibility of the commanding officer of that activity to administer and utilize the facility to fulfill primarily the required needs of the activity to which it is assigned. Secondarily, it is the commanding officer's responsibility to fulfill the needs of those other naval activities in the vicinity which do not have authorized photographic facilities.

An officer designated as the photographic officer, under the commanding officer, is charged with the administration of the photographic laboratory and is responsible for all photographic work performed therein.

Funds for the operation of official photographic laboratories are provided by the command which exercises management control over the lab.

USE OF NAVAL PHOTOGRAPHY

Naval photography, which includes aerial, surface and subsurface still and motion pictures, is used for varied purposes. In many instances photography provides the sole means of obtaining and transmitting vital information. Through reconnaissance photography, timely, adequate, and reliable intelligence data may be obtained on the strength and disposition of enemy fleets, aircraft, shore batteries, and enemy terrain of a military or potentially military nature. It is used to record battle action, scientific, and historical events, and has unlimited value in training and Navy public relations. To be of value, photography must be promptly forwarded to the ultimate user.

CLASSIFICATION AND SECURITY

The classification and security of photography within the Naval Establishment are in accordance with chapter 11 of the Security Manual for Classified Information. OpNav Instruction 5510.1 Series, plus other articles contained in that Manual; the United States Navy Regulations, 1948; and any Navy Department General Order or Instruction which has been or may be issued pertaining to security. Chapter 11 of the Security Manual for Classified Information titled "Control of Photography," is included as appendix A in the Manual of Naval Photography, OpNav Instruction 3150.6 Series, for guidance of all personnel handling such photography as may be undertaken within the Naval Establishment.

OpNav Instruction 5511.19 contains instructions relative to the classification of aerial photography, and the OpNav Instruction 5500.40 Series provides guidance for automatic time-phased downgrading of classified documents which include photography as noted therein.

Purpose of the Security Program

Basically, the purpose of the security program is to protect classified material from unauthorized disclosure.

It is the responsibility of every officer and man in the Navy to safeguard classified information. The PH must be especially vigilant since he frequently comes in contact with classified material.

Security Manual

The Department of the Navy Security Manual for Classified Information, OpNavInst 5510.1( ), is designed to furnish standards for handling classified matters. The manual itself does not guarantee security but makes security more readily attainable. Detailed instructions pertaining to the handling of classified matter can be found in this manual.

It must be remembered, however, that there is no adequate substitute for continuous day-to-day practice in the proper methods of handling classified material.

Security Principle

The Department of Defense employs a security formula which is simple in principle. It is based on the theory of circulation control—the control of the dissemination of classified information. Therefore, knowledge or possession of classified information is permitted only to those who actually require it in the performance of their duties, and then only after they have been granted the appropriate security clearances. This principle is generally referred to as a "need to know," and is a prime requisite for access to classified information.

Access to classified material is not automatically granted because a person has the proper clearances, holds a particular billet, or is sufficiently senior in authority, but only if the criteria of proper clearance and "need to know" are both met.

Limitations of Security

Security is a means–not an end. Rules which govern security of classified matter are much the same as gunnery safety rules. They do not guarantee protection and they do not attempt to meet every situation.

Security regulations are not intended to restrict the initiative of mature individuals. With common sense and mature thinking, it is possible to obtain a satisfactory degree of security with a minimum of sacrifice in operating efficiency.

Classification Categories

Official information which requires protection in the interest of national defense is limited to one of three categories: Top Secret, Secret, or Confidential. No information may be withheld or classified, if otherwise releasable, simply because such information might reveal an error or inefficiency or might be embarrassing.

Top Secret

The use of the classification Top Secret is limited to defense information or material which requires the highest degree of protection. Top Secret is applied only to that information or material, the defense aspect of which is paramount and the unauthorized disclosure of which could result in EXCEPTIONALLY GRAVE DAMAGE to the Nation, such as the following:

1. Leading to a break in diplomatic relations, armed attack on the United States or its allies, or a war.
2. The compromise of military plans or scientific or technological developments vital to the national defense.

Secret

The use of the classification Secret is limited to defense information or material, the unauthorized disclosure of which could result in SERIOUS DAMAGE to the Nation, such as the following:

1. Jeopardizing the international relations of the United States.
2. Endangering the effectiveness of a program or policy vital to the national defense.
3. Compromising important military or defense plans, scientific or technological developments important to national defense.
4. Revealing important intelligence operations.

Confidential

Information or material classified Confidential is placed in the category whose unauthorized disclosure could be PREJUDICIAL to the defense interest of the Nation.

If it is desired to understand more thoroughly the various categories of classified matter, the Security Manual has a number of examples in each category. However, the most important thing to be learned at this time is that each category represents a degree of damage to the Nation that could be done by letting this material get into the hands of unauthorized persons. The category also determines how the material is handled and the measures used for its protection, as will be seen later in this chapter.

Special Categories

Theoretically, the three classifications discussed above should safeguard any information desired. However, there are several other safeguards prescribed for use. These are not security classifications, as such, but indicate an increased degree of security to be applied when handling items thus marked.

Restricted Data

Restricted Data is assigned to documents or material concerning the design, manufacture, or utilization of atomic weapons; the production of special nuclear material; or the use of special nuclear material in the production of energy, unless such data or materials have been removed from this category by the Atomic Energy Commission.

For Official Use Only

"For Official Use Only" is assigned to official information which requires protection in accordance with statutory requirements or in the public interest, but which is not within the purview of the rules for safeguarding information in the interest of national defense. Its description, use, and limitations are set forth in the effective edition of SecNav Inst. 5570.2.

Special Handling Required/Not Releasable To Foreign Nationals

The term "Not Releasable to Foreign Nationals" is assigned to classified documents to prevent inadvertent disclosure to foreign nationals. This term is often abbreviated within the Intelligence Community as NOFORN, and when assigned to classified documents it indicates: (1) that the documents are furnished for the exclusive use of the U.S. military representatives on international staffs or in similar circumstances; (2) to holders and other handling personnel that the documents involved have already been reviewed by the office of origin or other responsible authority, and that disclosure to foreign nationals is subject to special restrictions.

Another control marking used to help prevent inadvertent disclosure to foreign nationals is NO FOREIGN DISSEM. This control marking is used when it is determined by the originator of a classified intelligence document that the intelligence information contained therein must not be released to foreign nationals or foreign governments in any form.

Classified intelligence documents or non-intelligence documents, even though they bear no control markings, may not be released to foreign nationals or foreign governments without prior approval of the Chief of Naval Operations. Therefore, all classified documents, whether so marked or not, are NOFORN.

Special Access Programs

"Special Access Programs" are those programs identified with specific projects or subjects requiring security protection or handling not guaranteed by the normal security classification and requiring that the program materials be handled and reviewed only by specially cleared or authorized personnel.

The administrative responsibility for any special access program rests with the command having the need for a special access program.

Methods Used to Subvert U.S. Military Personnel

The methods used by foreign intelligence agents to subvert U.S. Military personnel are many and varied. A few of the more common methods are mentioned in the following paragraphs to alert the PH to the possible dangers of entrapment.

In recent years foreign agents have shown considerable success in "hooking" Americans and their allies by a variety of methods. In many instances these entrapments have occurred because of the gullibility, carelessness, ignorance or recklessness of the personnel concerned. During recent years, it has become more and more common for U.S. Military personnel to visit foreign countries. This has come about either due to military commitments or simply because foreign travel during leave periods has become more popular. Also, more and more foreign visitors come to the United States. We must therefore expect that both at home and abroad there will be a continuing and perhaps increasing chance that apparently innocent contacts can become an inadvertent compromising situation where classified information is concerned.

Some examples of methods used to place unsuspecting individuals in compromising situations are: flattering him, praising his ideas; doing everything for him, so that after a while he comes to depend on the agent and his fellows for friendship and support; catching a person in an embarrassing situation or staging such a situation and then blackmailing him; bribing a man to do something that appears relatively innocuous, and then holding forth threats of exposure plus bigger bribes in order to get him to perform more serious acts; threatening a person with harm to himself or his relatives.

A classic instance of entrapment by foreign agents, which has been repeated many times, goes as follows: The individual is gotten drunk (or drugged) at a tavern or party, or is invited to a woman's (or man's) apartment. Then he is photographed. Often the agent will not use the blackmail material right away, but wait years in the hope that the person will rise to a position of greater influence or of access to important information. Or, the agent will ask for just a small favor and pay money for it; this is done in order to have even stronger blackmail leverage against a person who might decide to face the consequences of his misbehavior voluntary or forced.

In some instances foreign agents, or their police, have arrested people accusing them of espionage, stealing, or immorality. The agents plant the evidence on the person and then claim that when he returns home–if ever–no one will believe he was innocent. Next, the agents arrange a deal whereby the person will be released if he will do something for them. This act can be quite innocent appearing, but later becomes a means of blackmail.

Service men should be alert to possible traps; they should avoid being alone in certain areas, especially overseas, and they should not ask for trouble by going into various locations–out of curiousity, bravado, or ignorance.

Communists and other foreign agents have proved that they are willing to "play dirty ball" and their methods have ranged from subtle, long term corruption, to quick, blatant blackmail methods. Photographer's Mates who have access to classified matters and whose actions can be exploited for propaganda purposes are prime targets. Navy men must be alert, and careful in their conduct, and should report any unusual contacts or invitations to their superiors.

Violations and Compromises

Any person having knowledge of the loss or possible compromise of classified matter must report the fact immediately to his commanding officer. The commanding officer then takes the proper action as outlined in detail in the Security Manual; chapter 8.

Violations of regulations pertaining to the safeguarding of classified information, but not resulting in its loss, compromise, or disclosure, are acted upon by the commanding officer.

It is vital that every PH who handles classified be completely familiar with paragraph 0815 of the Security Manual. This paragraph sets forth the policy for disciplinary action in the case of violations of security.

It must always be remembered that the PH is responsible for classified material in his care. Anyone who mishandles classified material is disciplined by his commanding officer or by a court-martial, depending on the circumstances.

Personal Censorship

There is no way of estimating how many battles have been lost, how many ships were sunk, or how many lives were sacrificed because someone casually, or in a moment of boasting, unintentionally betrayed a vital military secret.

It is quite natural for a man to be proud of the work he is doing. He wants to share this pride with his friends and family. Enthusiasm toward one's work is clearly a desirable trait, but not when it results in discussing classified information.

To maintain security one should decline to discuss official matters by skillful maneuvering of the conversation or by outright refusal to talk shop.

Stowage

The first obligation of any person working with classified material is to protect that material. Top Secret, Secret, or Confidential material may neither be removed from its designated working space without approval of competent authority nor left unguarded. It is kept locked in its proper accommodation, for a single glance at a classified intelligence plan might compromise the entire plan. Another danger is that a photograph might be taken in a split second with a concealed camera.

It has been stated that the Navy's security system operates on the principle of "need to know." It is essential then, that combinations and keys to classified containers be known only to those who are actually using the material in their work. To insure this, certain rules must be followed.

The combination or key to a security container should be changed at the time it is received, at the time of transfer of any person having knowledge of it, at anytime there is reason to believe it has been compromised, or in any case at least once every 12 months.

If a container in which classified material is stowed is found unlocked in the absence of assigned personnel, it should be reported immediately to the senior duty officer. The unlocked container must be guarded until the duty officer arrives at the scene. The duty officer then inspects the classified material involved, locks the container, and makes a security violation report to the commanding officer. Appropriate further action is taken by the commanding officer.

It should be noted that other government agencies, such as the Air Force, do not use the Numerical Evaluation System presented in chapter 6 of the Security Manual for determining custody allowances for classified material, and when assigned to joint commands it is advisable to determine the governing security regulations in effect there.

Accounting

Except for publications containing a distribution list by copy number, all copies of Top Secret Documents must be serially numbered at the time of origination in the following manner: "Copy No.____ of____ copies." (See fig. 2-1.)

A list of all persons having knowledge of a particular item of Top Secret information must be maintained and a continuous chain of receipts kept to insure positive control. The control of Top Secret material is the duty of the Top Secret Control Officer.

Commanding officers establish administrative procedures for recording all Secret material originated and received, and maintain a receipting system for all Secret material distributed or routed to activities within their commands. As a general rule, Secret materials are also serially numbered.

Commanding officers also provide accountability for all Confidential materials originated or received by their commands.

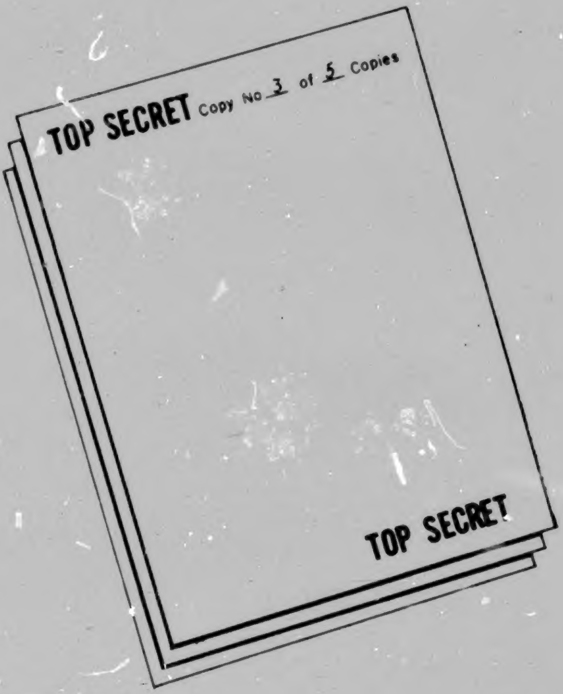

TOP SECRET Copy No 3 of 5 Copies
TOP SECRET

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Figure 2-1.—Numbering of classified copies.

Custodial Precautions

Each individual in the Naval Establishment should take every precaution to prevent deliberate or casual access to classified information by unauthorized persons. Some of the precautions are discussed in this section.

When classified materials are removed from stowage for working purposes they should be kept face down or covered when not in use.

Visitors not authorized access to the particular classified information within a working space should be received in a specially designated visiting space.

Classified information should never be discussed over a telephone. Remember also that a telephone scrambler device does not insure security.

If for any reason, a room must be vacated during working hours, all classified material in the room must be locked in its proper stowage containers.

At the close of the working day a system of security checks should be carried out to insure that the classified material is properly protected. All classified material must be properly stowed. All classified material which must be passed from watch to watch has to be properly accounted for. All burn bags should be burned or properly stowed. The contents of wastebaskets which contain classified material must be burned or stowed. All classified notes, rough drafts, and similar papers are placed in the burn bag during the day as a matter of routine.

Personnel concerned with locking combination locks or safes must remember to rotate the dial of all combination locks at least three turns in the same direction when securing them. In most locks, if the dials are given only a quick twist, it is generally possible to open a lock merely by turning the dial back in the opposite direction. Also, responsible personnel are assigned to check all drawers of safes and file cabinets to assure that they are held firmly in the locked position when secured.

In the event of a fire alarm or other emergency, classified material is stowed in the same manner as at the end of a working day. Each person who has classified material in his possession at the time of a fire alarm or other emergency assures that the material is properly safeguarded.

Other examples of handling classified material during emergencies are discussed in the Security Manual.

Disposition of Classified Material

When military personnel resign or are to be separated from the Navy or released from active duty, all classified material held by them is turned in to the source from which it was received, to their commanding officer, or to the nearest naval command, as appropriate, prior to the delivery of final orders or separation papers.

Personnel to be separated from the Navy or to be released to inactive duty submit to their commanding officer a signed statement to the effect that they have turned in all classified material. Also, they are instructed that they are not to reveal classified information, of which they might have knowledge, even after discharge.

Transmission of Classified Material

Any time material leaves the hands of an originator and is sent on its way to the addressees, it is TRANSMITTED. Whether it goes by courier, by radio, or by mail, if it is classified, it has to be safeguarded. The only possible way to obtain absolute transmission security is to refrain from communications over an extended period. Of course, this is impossible. Since the PH may be involved in the production of classified material, it follows that he will also be concerned with its transmittal. Therefore, it is necessary that he have a thorough understanding of the rules for transmitting classified material.

Method of Transmission

Top Secret material may be transmitted by direct personal contact of officials concerned, Armed Forces Courier Service, or electric means in encrypted form. Top Secret material must not be transmitted through the United States postal system or any foreign postal system.

Secret material may be transmitted in any of the means approved for transmittal of Top Secret material and by United States registered mail. Confidential material is handled in the same manner as Secret.

Top Secret material may be personally transmitted by military personnel, pay grade E-7 or above, and U.S. civilian employees, grade GS-7 and above. In addition, military personnel in pay grade E-5 and E-6 and U.S. civilian employees in grade GS-5 and GS-6 may transmit Top Secret material between Department of Defense elements located in relatively close proximity to one another, provided the transmission is completely accomplished during normal daylight duty hours on the same day. In addition, all personnel transmitting Top Secret material must be cleared for access to Top Secret information and be specifically designated in writing to act as a courier.

Preparation of Material For Transmission

Whenever classified material is transmitted by other than electrical means in encrypted form, it must be enclosed in two opaque sealed containers. As long as this requirement is observed, the material may be wrapped, boxed, or crated, or a combination thereof.

Classified written material must be folded or packed in such a manner that the text will not be in direct contact with the inner container. A receipt form must be attached to or enclosed in the inner container for all Top Secret and Secret material. Confidential material will require a receipt only if the originator deems it necessary.

The mailing of written materials of different classifications in a single package should be avoided whenever possible. When it is unavoidable to send material of more than one classification in a single package, the inner container must be marked with the highest classification of the contents.

The inner container must show the address, classification (including where appropriate the "Restricted Data" marking), and any applicable special instructions. It must be carefully sealed to minimize the possibility of access without leaving evidence of tampering.

The outer container must show the complete and correct address and the return address of the sender. This may be omitted for shipments in full truckload or carload lots.

The outer container must not bear a classification marking, a listing of the contents divulging classified information, or any other unusual data or marks which might invite special attention to the fact that the contents are classified.

Destruction of Classified Material

Classified material not required by a command must not be allowed to accumulate but must either be turned in to the appropriate office or be destroyed.

Top Secret, Secret, and Confidential material may be destroyed by burning, pulping, pulverizing, or shredding, provided destruction of the classified material is complete and reconstruction is impossible.

Destruction of classified material must be accomplished in the presence of two witnessing officials. A witnessing official may be a commissioned officer, warrant officer, enlisted man in pay grade E-7 or above, or U.S. civilian employee in grade GS-7 or above. If none of these categories is available, a mature and reliable enlisted man in pay grade E-5 or E-6, or U.S. civilian employee in grade GS-5 or GS-6 may be designated as a witnessing official. All persons witnessing the destruction of classified material must have a security clearance at least as high as the category of material being destroyed, and they must be thoroughly familiar with the regulations and procedures for safeguarding classified information.

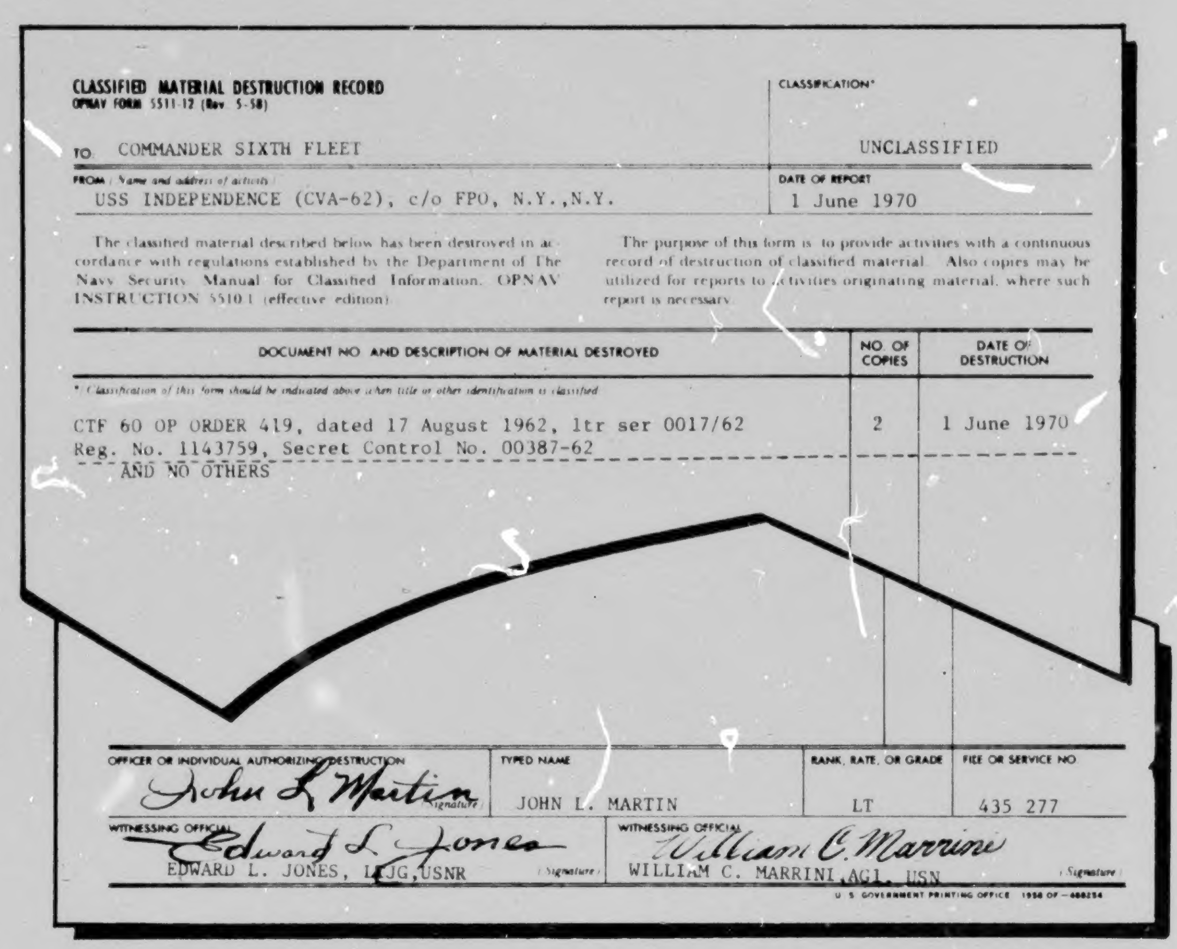
When appropriate, certificates of destruction are prepared and signed by the witnessing officials. (See fig. 2-2.)

Witnessing officials must observe the complete destruction of the classified material. The residue must be checked to determine if destruction is complete and reconstruction is impossible. Efforts must be made to insure that portions of burning material are not carried away by wind or draft.

CONTROL OF NAVAL PHOTOGRAPHY

Officers in a command status are responsible for controlling the photographing of all matters within their jurisdiction. This applies to official and unofficial photography, regardless of whether the photographers are private citizens or attached to the Naval Establishment. Additional directives are promulgated by commands as necessary to control photography within the respective command.

In order to prevent competition with civilian photographic organizations, certain restrictions are placed on the disposition and publication of all official photographs taken with Navy equipment. Under existing Department of Defense regulations, using established procedures, photographs can be released to the press or news media or even private agencies. When photographs are desired for private use, the request should be made to the Commanding



CLASSIFIED MATERIAL DESTRUCTION RECORD
OPNAV FORM 5511-12 (Rev. 5-58)

CLASSIFICATION*: UNCLASSIFIED

TO: COMMANDER SIXTH FLEET

FROM (Name and address of activity): USS INDEPENDENCE (CVA-62), c/o FPO, N.Y.,N.Y.

DATE OF REPORT: 1 June 1970

The classified material described below has been destroyed in accordance with regulations established by the Department of The Navy Security Manual for Classified Information, OPNAV INSTRUCTION 5510.1 (effective edition).

The purpose of this form is to provide activities with a continuous record of destruction of classified material. Also copies may be utilized for reports to activities originating material, where such report is necessary.

DOCUMENT NO. AND DESCRIPTION OF MATERIAL DESTROYED	NO. OF COPIES	DATE OF DESTRUCTION
CTF 60 OP ORDER 419, dated 17 August 1962, ltr ser 0017/62 Reg. No. 1143759, Secret Control No. 00387-62	2	1 June 1970
AND NO OTHERS		

* Classification of this form should be indicated above when title or other identification is classified.

OFFICER OR INDIVIDUAL AUTHORIZING DESTRUCTION (Signature)	TYPED NAME	RANK, RATE, OR GRADE	FILE OR SERVICE NO.
John L. Martin	JOHN L. MARTIN	LT	435 277

WITNESSING OFFICIAL (Signature)	WITNESSING OFFICIAL (Signature)
Edward L. Jones EDWARD L. JONES, LTJG,USNR	William C. Marrini WILLIAM C. MARRINI,AG1, USN

U. S. GOVERNMENT PRINTING OFFICE 1958 OF—468254

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Figure 2-2.—Classified Material Destruction Record.

Officer, Naval Photographic Center, Naval Station, Washington, D. C. 20390.

Procedures have been established for the proper collection of fees when appropriate photographs of newsworthy events and public relations may be released to news media through proper channels.

Photographic facilities are established, equipped, and supplied to accomplish photography for official use only. Equipment will not be utilized for other than its intended purpose. The use of Navy photographic equipment and material beyond the confines of the ship, unit, activity, or station, except for official assignments including scheduled training programs, is prohibited. The use of government equipment or materials for personal profit or gain is in violation of the United States Navy Regulations (1948), Article 0787.

LABORATORIES AND FACILITIES

The Chief of Naval Operations (Op-346) will establish and disestablish photographic laboratories. Under emergency or wartime conditions, additional laboratories may be authorized by cognizant fleet commanders. The Office of the Chief of Naval Operations, the Commander, Naval Air Systems Command, and the supporting Naval Aviation Supply Depot must be advised of laboratories authorized under such conditions in order than appropriate records may be adjusted accordingly. Disestablishment of a laboratory will be effected by the Chief of Naval Operations when the volume of work does not justify its continued operation and maintenance. The Chief of Naval Operations must be informed when a laboratory is no longer required.

Shore-Based Laboratories

Requests for authorization to operate a shore-based photographic laboratory or for change in laboratory classification is submitted to the office of the Chiel of Naval Operations via the chain of command including the management bureau or office. The management bureau or office will indicate in the forwarding endorsement recommendation for approval or disapproval and confirmation of financial support if approved. The command requesting the laboratory must furnish complete justification.

Shore-based photographic laboratories are classified according to size, processing equipment, and work capacity. Photographic designators are assigned by the letter authorizing the laboratories.

Laboratories Aboard Ship

Newly constructed ships in which plans and construction have included photographic laboratory spaces are issued the appropriate allowance during initial outfitting of the ships.

Reserve fleet ships having authorized photographic laboratory spaces are issued the appropriate photographic allowance during initial outfitting or reactivation of the ships. An exception to this will be the instance in which a recommissioned ship is employed in service other than that normally assigned to ships of its type.

Ships not having authorized photographic laboratory spaces or allowances, if required, submit a request to the office of the Chief of Naval Operations, via the chain of command and the Naval Ship Systems Command. Requests should include recommended location of the laboratory, space and weight and moment compensation, and whether ship alteration is required. A statement indicating that qualified photographic personnel are, or will be, on hand to operate and maintain the equipment should be included in the request.

Ship photographic classification will be the same as the ship designation. Thus, the U.S.S. Franklin D. Roosevelt laboratory classification would be CVA.

Equipment

The Commander, Naval Air Systems Command prepares and publishes the Section P Allowance Lists of Photographic Material applicable to all activities of the Naval Establishment authorized by the Chief of Naval Operations to operate photographic laboratories other than class "Special" or G.

Allowance lists serve as a guide for the photographic supply points in screening requests for material submitted by operating laboratories and should assist the operating laboratories in estimating requirements for the purpose of obtaining operating funds. Activities shall not exceed the assigned equipage allowance except upon the specific authority of the management bureau or office and the Commander, Naval Air Systems Command. The allowance lists also contain consumable material allowances. These are not restrictive and may be exceeded as to items or amounts in accordance with existing requirements.

Personnel

Enlisted photographic personnel assigned to activities not authorized to operate official Navy photographic laboratories (such as patrol squadrons), are assigned to the laboratory in the ship or station upon which they are based, on temporary duty or special detail to augment the ship or station photographic force.

The following exceptions to this practice are authorized:

1. Photographic squadrons based ashore and not operating an authorized photographic laboratory assign only sufficient personnel on

temporary duty, to enable the supporting photographic laboratory to adequately fulfill the squadron's requirement for support, commensurate with normal photographic operations.

2. Photographic detachment personnel are specially trained in aerial cameras, aircraft installations, photographic aircraft control systems, and related equipment and are not assigned to the ship's or station's photographic laboratory except in emergency situations, and then only when such assignment will not adversely affect the detachment's photographic capability.

3. Personnel of Combat Camera Groups when ordered to naval activities or embarked in naval ships have been assigned specific photographic projects to accomplish. In order that these projects are accomplished expeditiously, these personnel will not be assigned to the local laboratory or assigned other military duties which will interfere with the accomplishment of their primary mission.

4. In the case of a fleet activity based ashore and operating an authorized photographic laboratory in addition to or in lieu of a station laboratory, other fleet activities shall assign their photographers to the fleet operated photographic laboratory.

5. Photographer's mates attached to patrol squadrons who are assigned as crewmembers in a flying status.

PHOTOGRAPHIC LOGISTICS

Before discussing photographic logistics it is well to first define the word "logistics." The late Secretary of Defense, James Forrestal, had this to say: "Logistics is the process of providing what is needed, when it is needed, where it is needed. It embraces the supply and distribution of men and materials, storage, distribution, maintenance, repair, and replacement of equipment. It is the procurement, training, billeting, feeding, distribution, staging, hospitalization, replenishment, and rehabilitation of personnel."

Photographic logistics is divided into three phases: Shore Based Activities, Shipboard Activities, and Advanced Base Activities. In the first two activities the logistics are normally a matter of simple procedures, while in the latter, the situation becomes more complicated. Each phase is discussed separately here.

Shore-Based Activities

Photographic materials and equipments are supplied to shore-based activities according to their class, from materials stocked in a designated supply point in accordance with the photographic allowance list prepared and published by the Commander, Naval Air Systems Command. The allowance list for above activities is NavAir 00-35QP-6.

To replenish consumable supplies, a stub requisition must be submitted at the proper time as stated in the Naval Air Systems Command Manual, Volume 2, paragraph 27471-Procurement and Distribution System. The estimation of future requirements of expendable supplies and the submitting of requisitions correctly and on time is one of the most important details in the photographic activity. This prevents overstocking and waste, or exhausting stock and curtailing operations.

Personnel are supplied by rating to a shore based activity in conformance with an allowance list which is established for each activity by BuPers. This allowance list is not always filled by the specified rates. A situation such as this clearly emphasizes the necessity for a continuous training program within the activity in order to qualify personnel for the advancement in rating. If the workload increases to the point at which additional personnel are required, or the type of work changes in such a manner that a change in the number allowed for a particular rate is justified, the commanding officer may request BuPers to establish a new allowance list for the activity, consistent with the present or proposed workload.

All photographic personnel are assigned by the photographic officer and the leading chief to billets within the photographic laboratory where needed and, if possible, where best qualified. Billets should be changed at specific intervals in order that each man may increase his photographic knowledge and experience.

All shore-based activities are required to conduct a training program for personnel attached to the unit. The photographic officer is responsible for proper supervision, indoctrination and training of his personnel in the use of aerial, motion picture and still camera equipment. To supervise the training of photographic personnel in the latest developments and techniques in naval photography, certain publications are available. Some of these are: Navy Department Technical Bulletins, Navy Technical Orders, Navy Department Bulletins, OpNav Instructions, Army-Navy Service Bulletins and Technical Orders, and Air Force Technical Orders on Photography.

Shipboard Activities

Standards for the procurement of photographic material and equipment for shipboard laboratories are issued by the Commander, Naval Air Systems Command. NavAirSysCom directs shipment of the commissioning allowances for all ships by issuing shipment requests on the photographic supply activity nearest the outfitting point of the vessel. Installation items are normally made available to the builder's yard at least 90 days prior to the commissioning date; other items, 30 days prior to the commissioning date.

Replenishment, of consumable supplies and equipment needing repair will be accomplished through the ship's supply department on a stub requisition according to the NavAirSysCom Allowance List, Section P, NavAir 00-35QP-2—Forces Afloat for Aircraft Carriers and Sea Plane Tenders. NavAir 00-35QP-3 is the allowance list for other ships.

Maintaining necessary stock on hand for the workload and anticipated length of time the ship expects to operate, is very important due to the probable distance from the supply point. Sufficient stock should always be on hand. Often, a change of orders while underway may lengthen the trip and, in such a case, insufficient materials aboard will result in a stoppage of photographic work before the end of the cruise.

A photographic personnel allowance list is set up by BuPers for each type of ship. The actual number of men assigned will vary, with the total number dependent on the size of the ship an[illegible] prospective workload. In the case of an airc[illegible] carrier, the workload in the photogra[illegible] department is often relieved by the presence of the photographic personnel assigned to air groups or squadrons.

Actual duty stations within the shipboard laboratory are assigned in the same manner as outlined earlier under "Shore-Based Activities." The training program is also similar with the exception of the different phases of training in the area of flight deck operations. This curriculum is added to the training schedule aboard ship.

Advanced Base Activities

Logistics requirements and sources for advanced base activities require much planning and forethought. An Advanced Base Functional Component Catalogue is prepared and published by the Chief of Naval Operations, listing photographic equipment and materials needed for this type of unit.

Logistics planning will depend upon the location, the time, and size of the unit, anticipated workload, and length of time the unit will operate. Generally 6 months to a year is spent planning and procuring equipment and material for advanced base operations. The best way to determine the requirements for an advanced base activity is to study each phase of the planned assignment step by step. Many Navy and Air Force publications and bulletins are available on such subjects as airborne photographic equipment, cold weather photography, sea water processing, time-temperature development tables for sensitized materials, and Task Force photographic summaries and reports.

The availability of supplies for replenishment will depend upon the distance from the supply point and the method of delivery. When it is necessary to replenish consumable supplies, arrangements must be made through the nearest supply activity. If the advanced base is too far away from the supply point, anticipated needed materials will have to be stored nearer the advanced base.

A personnel allowance for this type activity is not set up in definite numbers by BuPers. The number and rate or rank of the photographic personnel required for advanced base operations is determined by the type of work to be accomplished, the size of the operation, and the length of time the activity will be operating. The foremost consideration in the assignment of personnel to a unit of this type is technical skill in all phases of naval photography. Generally, each man's record is screened and his selection is based on his experience in the phase or phases required for an operation such as this. Maximum proficiencey from each individual is required to insure the best photographic results.

The assignment of specific duties to personnel in advanced base units is usually done prior to the departure of the activity. Any necessary changes are made upon arrival of the unit in the advanced area.

Training is handled and accomplished prior to departure, with additional training, when possible, planned to fit into the time available when underway. Photographic instruction should be scheduled during free time periods at the base, for it is imperative that personnel be prepared for advancement in rate. All training is accomplished under the supervision of the photographic officer assigned to the mission.

LABORATORY ORGANIZATION

The organization of a photographic laboratory is discussed here as it is related to the assignment of duties to be performed by each of its members. The operating photographic laboratory can be compared to any large business firm in civilian life in that a system or plan of operation and administration must be adopted and applied in order that its basic military mission may be efficiently accomplished. The administration of all naval laboratories is conducted in accordance with regulations set forth in the Manual of Naval Photography, OpNav Instruction 3150.6 (Series).

PHOTOGRAPHIC OFFICER

The photographic officer in most instances is a graduate of the Naval School of Photography. He is responsible for maintaining the control of photography as it is defined in the Manual of Naval Photography. In his capacity as photographic officer, he is the official custodian of all accountable equipment within his laboratory. He also serves as division officer to the photographic personnel under his command.

The specific duties and responsibilities of the photographic officer are outlined in more detail in the U.S. Navy Manual of Naval Photography.

PHOTOGRAPHIC PROCESSING OFFICER

An officer designated as the photographic processing officer is assigned to ships with Integrated Operational Intelligence Centers. He is charged under the commanding officer with the responsibility for the operation of the photographic processing section of the Integrated Operational Intelligence Center. While his primary duty is to provide high speed, quality controlled photographic processing support to the Center, he is also charged with the specific duties of a photographic officer as listed in the U.S. Navy Manual of Naval Photography, OpNav Instruction 3150.6 (Series).

SENIOR PHOTOGRAPHER

The Senior Chief Photographer or leading chief of the laboratory serves as an administrative assistant to the photographic officer.

He accepts such photographic control and responsibility as may be delegated to him by the division officer. He is responsible for personnel management and the general overall supervision of laboratory functions.

The duties of the leading Chief Photographer's Mate are as follows:

1. Assist the photographic officer in the performance of his duties.
2. Supervise the maintenance of such records, files, logs, and reports as may be required by the laboratory.
3. Organize and supervise the photographic duties of the flight crews as well as laboratory production.
4. Supervise personnel of the unit as follows:
    a. Assign men to various phases of the work and plan for rotation at least once a quarter.
    b. Be responsible for Watch Quarter and Station Bill assignments.
    c. Assign photographic personnel to duty sections so as to maintain a well balanced and competent crew on duty at all times.

d. Insure that an adequate training program is in effect.

5. Direct the routing of job orders through the various stages of production. This direction concerns the following:

a. Taking pictures (aerial or otherwise).
b. Processing.
c. Printing.
d. Captioning.
e. Filing.
f. Forwarding.
g. Delivering of finished work.

CHIEF PETTY OFFICERS

Large photographic laboratories are generally staffed with several chief petty officers who are junior to the leading chief. They serve in various capacities, such as chief in charge of the aerial section, chief in charge of camera repair, chief in charge of production, chief in charge of material and storeroom, and chief in charge of the motion picture section. These personnel supervise their respective departments and keep the leading chief informed on all matters pertaining to their production and personnel.

Other Chief Photographer's Mates assigned to a unit are responsible for the operation of the department in the photographic laboratory to which they have been assigned. In addition they are responsible for the training of the men, quality of the work produced, and setting a good personal example of leadership for the men.

The chief insures that the men are trained to operate and maintain the equipment used in his department, and impresses upon the men the need for self-improvement. He sets up control measures to insure that only the best quality work is produced by the men.

SENIOR PETTY OFFICERS

Senior first class petty officers are assigned to direct and supervise the actual work performance of lower rated photographic personnel in the various phases of production as it progresses through the laboratory.

Responsibilities

In most photographic units, first class petty officers hold the position of section leaders with full responsibility for their respective sections.

Duties

Specific duties include:

1. Checking the Camera Ready Locker immediately after morning quarters, with special attention to the following:

a. Assuring that cameras are loaded and equipment is complete.

b. Assuring that ready cameras and equipment are in working order.

2. Expediting laboratory work.

3. Disseminating information to lower rated men, as follows:

a. Supervising on-the-job training.

b. Conducting classroom training for improvement in proficiency and preparation for advancement.

4. Familiarizing assistant section leader and other members of crew with military and professional responsibilities and duties.

5. Supervising the maintenance and upkeep of laboratory equipment.

6. Maintaining laboratory cleanliness.

7. Assisting the photographic officer and leading chief in the establishment of a training program.

JUNIOR PETTY OFFICERS

Junior petty officers are rated Photographer's Mates who fill the various billets within the laboratory organization. Their duties consist of laboratory production work in the darkrooms as well as photographic coverage in the field with camera equipment. Junior petty officers are also charged with the responsibility of supervising and instructing non-rated personnel in the many aspects of their rate.

LABORATORY CREWS

Actual photographic production is divided into two phases—field work and laboratory work. Each member of the photographic laboratory has a specific assignment within the organization. The working stations within the unit are manned by photographic crews who rotate periodically from one photographic phase to another. The duties and job performance requirements of the crews are discussed in the following paragraphs.

1. SHOOTING CREW. The shooting crew, responsible for the ground still or motion picture field work, generally consists of qualified and experienced cameramen. They accomplish all photographic assignments outside of the photographic laboratory during working hours. They are responsible for complete captioning information during the course of the assignment, including acquisition of a classification for each photograph. This information is obtained from the activity requesting the photograph. Upon return to the laboratory they are required to fill out standard job orders forms for assignments completed. Unless a separate developing crew is used, members of the shooting crew are required to process all of their own film. If the shooting crew is doing the laboratory work, its members are further responsible for the condition of all chemicals necessary to perform their duties completely.

The shooting crews also maintain a sufficient amount of film available for immediate use with the cameras and flash units, and are also responsible for normal maintenance of the cameras and equipment assigned to them.

Motion picture cameramen have similar duties and responsibilities to those of the still men; however, the technical procedures differ somewhat. Shooting techniques for still photography and motion picture photography have been covered thoroughly in Photographer's Mate 3 & 2, NavTra 10355.–A.

2. COPY ROOM CREW. The copy room crew performs all shooting assignments within the laboratory. Its members are responsible for the proper choice of film, filters and exposures necessary for the successful completion of each job they are assigned. They must be capable of applying proper development techniques so that full tone and scale details are apparent in each piece of copy work. They are required to develop, wash, and dry their own film and upon completion of the job they must properly caption each of the negatives, including proper classification. They are also responsible for the normal maintenance and care of equipment used in the performance of their duties. Personnel attached to the copy room must make certain that an adequate supply of fresh chemicals is on hand each day.

3. PRINT CREWS (CONTACT AND ENLARGING). The print crews perform all printing requirements, in job order sequence, or in conformance with laboratory policies and procedures. High standards of print quality are mandatory and every man assigned to the print rooms is responsible for maintaining these high standards. The delegation of duties within the print rooms is up to the senior petty officer in charge. Periodic rotation of personnel is recommended. Sufficient chemicals should be on hand at all times. It is the duty of each person working in this area to insure this at the beginning of each working day.

4. FINISHING CREW. The finishing crew is responsible for removing all dry negatives from the film drying cabinets and forwarding them to the production desk for screening and disposition by the production supervisor. Finishing personnel are also required to dry all prints when washing has been completed. After drying, prints must be assorted and matched with the original negatives; they must then be given negative file numbers, stamped, and captioned in accordance with laboratory requirements. All prints must be carefully inspected for improper contrast, scratches, and other blemishes including uneven borders. Those considered unsatisfactory must be destroyed and the negatives returned to the print room for reprinting. Upon completion of all finishing requirements, the complete job must be forwarded promptly to the job order desk for delivery.

5. PRODUCTION DESK CREW. The production or job order desk crew is responsible for the maintenance of job order continuity on all job requests entering the laboratory. They are required to properly fill out standard job order forms and at the same time make appropriate entries in the job order log and on the job production board if there is one maintained.

The production crew also maintains the negative and print files in numerical sequence.

Qualified personnel in this phase of photographic production are also responsible for the maintenance of files classified as Confidential. They are required to be thoroughly familiar with the laboratory policies regarding the handling of classified material. Production crews are expected to perform routine office duties which include typing, filing, records, job deliveries, and personal contact by telephone or in person with job requestors.

6. FLIGHT CREWS. Flight crews include personnel assigned to the laboratory who are qualified in aerial photography. Members of these crews are generally assigned to any of the previously discussed laboratory billets, but become flight crew personnel in accordance with the scope of the aviation operational functions of the laboratory.

Flight orders are usually assigned to personnel on a monthly rotating basis, dependent upon the number of flight orders issued to the laboratory by the operations department. Station regulations specify the number of flight orders to be assigned to the unit.

Normally, only qualified men are granted flight orders; however, local laboratory policy often allows unqualified photographic strikers the opportunity to become eligible for aerial photographic duty. This is in accordance with aerial photographic training programs which are included in the overall mission of naval photography.

ORGANIZATION OF THE LOCAL LABORATORY

The size, complement, tasks and services provided by the local laboratory vary widely throughout the Naval Establishment. Shipboard and shore station organizations vary with the role and mission to be performed. The organization to which you are assigned or likely to be assigned is probably already well established. If not, you as a supervisor can group your men into an organization to make them more effective. A good organization chart will partially serve this purpose. The organization chart should be constructed with the size of the unit, its allowance, and the mission to be performed in mind. It should utilize the skills, abilities, and knowledges available from your billet allowance to effectively perform the mission of the local laboratory.

It is not an easy task to establish a standard way of constructing charts. However, the following suggestions are considered to be practical.

1. The most reponsible position or person in charge is placed at the top and centered. Usually a second person or assistant in charge is placed directly below with major positions branching off both to the left and right. Minor positions are then listed under major ones.

2. To represent a unit or person on a chart use a rectangle. Use straight vertical and horizontal lines to show the command or authority line.

3. The rectangle should be divided with a straight horizontal line with the name of the position placed in the top half and the personnel working under this position in the lower half.

4. If possible, rectangles should be of uniform size especially in length as this leads to a more pleasing appearance. An exception to this would be the top or most important position being larger than the others.

5. Normally authority or command lines may enter or leave a rectangle at the center of the top, bottom or sides but do not run through a rectangle.

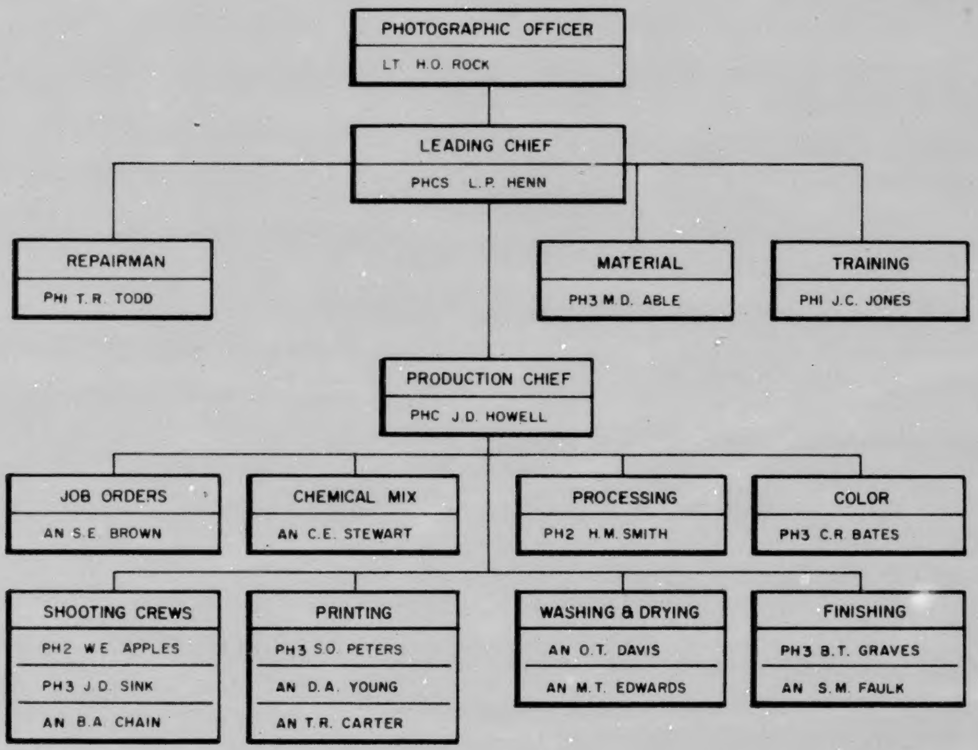
Figure 2-3 is an example of a typical organization chart.

Job Descriptions

Each job should be analyzed and the specific tasks required listed in a logical arrangement whereby each man performing this job knows exactly what his tasks and responsibilities are. A typical job description tells who he is responsible to and for what, his duties and tasks, and who he supervises. Each job that is done well is another building block that can be used to help the man become more skillful in his assigned tasks.

Induction and Orientation of New Personnel

Did you ever receive a man from another activity who knew only a minimum amount about his job? If you have, you realize what that


PHOTOGRAPHIC OFFICER
LT H.O. ROCK
LEADING CHIEF
PHCS L.P. HENN
REPAIRMAN
PH1 T.R. TODD
MATERIAL
PH3 M.D. ABLE
TRAINING
PH1 J.C. JONES
PRODUCTION CHIEF
PHC J.D. HOWELL
JOB ORDERS
AN S.E. BROWN
CHEMICAL MIX
AN C.E. STEWART
PROCESSING
PH2 H.M. SMITH
COLOR
PH3 C.R. BATES
SHOOTING CREWS
PH2 W.E. APPLES
PH3 J.D. SINK
AN B.A. CHAIN
PRINTING
PH3 S.O. PETERS
AN D.A. YOUNG
AN T.R. CARTER
WASHING & DRYING
AN O.T. DAVIS
AN M.T. EDWARDS
FINISHING
PH3 B.T. GRAVES
AN S.M. FAULK

PH.380

Figure 2-3.–Organization chart.

meant to your organization. It required several weeks of training for him to be able to perform in a manner acceptable to the quality standards of your office. Do not be guilty of this and create a problem for your successor.

When a new man is assigned to your office, he comes to you with habits he has formed, and his interests are his own and not necessarily like those of any others in your office. He may approach his job with little hidden fears and misgivings. You must make him welcome and give him a feeling of being a useful and desirable part of your group. What you do for this man is part of his induction, for which you are responsible. His ultimate value depends, to a large extent, upon how quickly and how well you help him adjust to his new unfamiliar surroundings. This cannot be postponed; it must start the first time you meet the new man and continue as long as he remains with you. This requirement can best be fulfilled with a supervisor's checklist for the induction of new men. The induction period is your greatest opportunity to win the man's loyalty, stimulate his interest, and get him into satisfactory production.

The supervisor's checklist should include items such as the following:

1. A review of his past experience, education, and training.
2. Have an up-to-date job description available for discussion with him.
3. An explanation of the work of the unit, the function of the unit, and the outline of the organization. Use this to indicate to him his position in the organization.
4. An explanation of the relation of his work to that of others and tell him to whom he reports and who reports to him.

5. He should be introduced to personnel in the office, and shown the layout of available facilities.

6. The rules, regulations, and policies of the organization should be thoroughly explained.

7. He should be given step-by-step instruction and checkout on his new job.

8. The quality and quantity of work standards should be explained.

9. A frequent check should be made on his progress.

Job Rotation

A plan of rotation covering several months should be worked out and posted on the bulletin board for information. The various types of jobs should be listed with the names of the men assigned and the period during which they will have the job.

Reliefs should be staggered so that the entire organization is not stalled at one time while all the men become familiar with new tasks. Men must be left in one place long enough to learn the work thoroughly. In the normal course of events they will learn the job assigned in many details of related work. If a man is expected to learn only one narrow phase, rotation may be scheduled as often as every month. Longer periods will allow him to learn more about the related jobs and 3 to 6 months is the more generally used period.

The rotation schedule should include relief of mess cooks and compartment cleaners. The men should know before going, if possible, what they will do when they come back. This makes for better morale, as an assignment which takes effect upon return to the division combats the feeling of many mess cooks that they have been abandoned. Scheduling in advance also eliminates the common belief that punishment of individuals is involved. Using such assignments as a form of punishment is indefensible. It is important that the men be made to feel that these unpleasant tasks have to be done by someone, that there is no favoritism, and that everyone eligible gets his turn.

By following a rotation schedule such as the one outlined in the preceding paragraphs you can assure that a man progresses in depth and scope of knowledge of the rating as he advances along the ladder. All of us have had the experience of receiving a man who was wearing the stripes but whose experience was limited to one or two narrow fields in the rating. When we get a good man in a particular job we are all too inclined to want to leave him in that job for his entire tour of duty. While this may make the organization look good it is doing an injustice to the man, the organization, and the Navy. At his next station he may be assigned a job entirely different from the one he was previously performing. Also, it may even be embarrassing to him if he is a senior petty officer, to find that he has to go about learning a job with which he should be familiar.

If the man is rotated at periodic intervals and allowed to become familiar with new jobs and new phases of the rating, he is less likely to get into a rut, his interest in the rating is stimulated, and the overall effect is that the Navy eventually benefits by having personnel well grounded in many phases of the rating. Another side effect which may not be readily apparent is the fact that confidence in performance and interest in the rating could have a great bearing on his decision to reenlist.

LABORATORY RECORDS AND REPORTS

In order to have a properly organized laboratory it is necessary to maintain proper records. To insure that the laboratories within the Naval Establishment will be uniform in this respect, a definite system has been established as set forth in the Manual of Naval Photography, OpNav Instruction 3150.6 (series).

Primarily, accurate records are needed for the following reasons:

1. To safeguard the handling of classified material.

2. To insure expedient delivery of classified and nonclassified material to the requesting unit.

3. To account for photographic equipment.

4. To account for the expenditure of material and maintain records of the materials on hand and on order.

5. To record all jobs pending and to account for the amount and type of work that has been accomplished in any specific time.

6. To maintain an accurate record and history on each man assigned to the activity.

7. As a reference for all classified and nonclassified negatives and prints on file.

8. To account for all official correspondence arriving and departing within the activity.

FORMS, LOGS, RECORDS, REPORTS

As the naval photographer advances up the rating ladder, administrative duties increase. A general knowledge of the procedure that is followed in keeping accurate records within a naval photographic laboratory is acquired, in most instances, early in the Navy photographer's career.

The first class and chief petty officer have the responsibility of training junior personnel in the proper maintenance of all records, files, and reports that are necessary to operate a naval photographic laboratory smoothly. It is essential that accuracy, simplicity, and clarity are stressed, for often the records on hand in a laboratory serve as references when administrative problems arise.

A most important factor in the preparation, handling, and maintenance of administrative forms and records is a thorough knowledge of security regulations of the Navy. Instructing in this subject is also the duty of the senior petty officer. Proper security must be maintained within the laboratory at all times. Classified material that is either passing through the laboratory on a standard job order or is on file within the unit must be safeguarded in accordance with existing security regulations.

Senior petty officers are required to be familiar with the Navy Correspondence Manual, SecNav Instruction 5216.5, current Navy filing instructions and directives, and the Navy Security Manual, OpNav Instruction 5510.1 (Series). The information contained within those publications should be disseminated among laboratory personnel through the training program and at morning quarters when the need arises.

NEGATIVE AND PRINT FILES

Every photographic laboratory maintains negative and print files in accordance with the instructions contained in the U. S. Navy Manual of Naval Photography. Negatives and prints classified Confidential or lower are filed in one file, and those classified Secret or above are filed in another file.

Complete data on still photography negatives which are classified Confidential or lower are entered in a still negative log, and the negatives are filed in numerical order. This log is classified Confidential and safeguarded in accordance with existing security regulations.

The Secret negative and print file contains all still photography negatives and prints classified Secret. The negatives and prints are filed in numerical order, kept in safes or vaults having locks of not less than three-way combinations, and are safeguarded in accordance with existing security regulations.

Complete data on all official still photographic negatives made which are classified Secret or Top Secret are entered in a local negative log. This log is classified Secret or Top Secret, depending on the information entered therein, and safeguarded in accordance with instructions contained in the security manual, or with existing security regulations. When Secret or Top Secret negatives are reduced in classification to Confidential or lower, they are logged in the still photographic negative log as of the data declassification is effective, the negative is filed in the negative file; and a mounted print is filed in the proper section of the still photographic print files.

Determining and Affixing Security Classification

Authority for original classification of information in the Top Secret and Secret categories is limited to those officials designated in the Department of the Navy Security Manual for Classified Information, OpNav Instruction 5510.1 (Series).

Derivative classification authority for assignment of the Secret classification may be exercised by any official whose duties necessitate classifying material created as a result of or in connection with material already classified Secret; or when acting on or responding to a communication requiring a Secret response.

Most photographic work classified Secret is in connection with material already classified Secret or when acting on or responding to a communication requiring a Secret response. It is the duty of the Photographer's Mate accepting assignments to ascertain the classification of photographic work performed and to insure the affixing of the security classification to the photographs, negatives, and data sheets.

All personnel are individually responsible for assuring that knowledge of classified information which they prepare or handle is made available only to persons who have appropriate security clearances and who have clearly established a legitimate "need to know."

PHOTOGRAPHS RELEASED FOR PUBLICATION

The proper classification and release of official U.S. Navy photography is a command function as set forth in chapter 11 of the U.S. Navy Security Manual, OpNav Instruction 5510.1 (Series). Released photographs of public information interest will be made available to the news media only through an established public information office or by qualified public information personnel.

All unclassified Navy photographs are required to be stamped "Official United States Navy Photograph–Released for Publication–Credit Line to read Official U.S. Navy Photograph by (Photographer's name)." Unclassified photographs are stamped "For Official Use Only" only when the subject matter is such that publication would prove inimical to the interests of the Navy or individuals depicted therein.

Full and accurate captioning is one of the most important, yet usually neglected, phases in the handling of still photographs. The necessity of providing the most complete information available, so that the greatest value can be obtained from the photograph, cannot be overemphasized. This means that each print of official photographs must be numbered and captioned completely. It should be remembered that it is impossible for anyone at a distance to know what may be obvious to those familiar with local conditions unless full information is given.

Laboratory records should indicate which photographs have been released and by what authority. The negative preserver and entries in the negative log should be used to record this information.

OBSOLETE FILES AND RECORDS

As Photographic files and records become obsolete it is necessary to dispose of them. As mentioned here these files and records include general correspondence and reports, data sheets, logs of still negatives and motion picture film, still picture negative files and motion picture film files. Still and motion picture films are integral part of the Navy's official documentation and should be carefully evaluated before being disposed of. Photographic Navy and Marine Corps records are evaluated and disposed of on the basis of their content, purpose, origin, and use in accordance with disposal authority provided in SecNavInst 5212.5B and OpNavInst 3150.6 (Series).

U.S. NAVY MANUAL OF NAVAL PHOTOGRAPHY

The U. S. Navy Manual of Naval Photography is an OpNav Instruction which you will find in every photographic laboratory. This instruction sets forth current policies, instructions, and procedures for the administration of Naval Photography. All personnel charged with the responsibility of administration and supervision of photography in the naval service should be well acquainted with its contents. As mentioned earlier in this chapter, the U. S. Navy Manual of Naval Photography sets up a uniform system of keeping records and making reports. This uniform system is important, particularly when one considers the rotation of personnel and submission of reports. Any recommendations for changes or corrections to this manual should be addressed to the Chief of Naval Operations (OP-346).

U. S. NAVY PHOTOGRAPHY TECHNICAL BULLETINS

Photography Technical Bulletins are primarily for the information and education of all personnel directly concerned with naval photography. They are published by the U. S. Naval Photographic Center under the direction of the Commander, Naval Air Systems Command. The purpose is to provide Navy Photographic Laboratories with useful technical information.

The bulletins are recommended reading for all photographic ratings and may be used as a basic of examination questions. Bulletins are published in loose leaf form with a special binder being provided for filing. Any inquiries or submission of material for future bulletins should be submitted to the Commander, Naval Air Systems Command (Air-5391).

MAINTENANCE OF PUBLICATIONS

Periodically, new publications or changes to current publications are distributed. It is the responsibility of the Photographer's Mate First Class or Chief to maintain these publications by inserting the change or by replacing an out-of-date publication with a current one. Too much emphasis cannot be placed upon keeping publications current; one change may affect the way an entire operation is carried out. Time, manhours, expense, material, and method could each be affected by a change. Success or failure of a job could depend upon whether the latest change or instruction was followed.

LABORATORY LIBRARY

It is a necessity that each photographic laboratory have as complete a library as possible. The library should include all government issue textbooks, training manuals, technical orders and bulletins, instructions and notices, and other commerical reference publications of a photographic nature that would help carry out the mission of naval photography. Several publications that should be found in every photographic library are the Manual of Naval Photography, Photo-Lab-Index, Technical Bulletins, and Training Manuals, Publications should be available to personnel at all times and they should be encouraged to read and study in order to maintain currency in the vast amount of technical knowledge necessary in such a rapidly expanding field.

The U.S. Navy Photographic Bulletin, NavAir 10-1TB-62, titled "Table of Instructions/Publications for Photographic Personnel" contains a list of instructions/publications for the information and education of naval photographic personnel.

The information contained in the instructions/publications listed in NavAir 10-1TB-62 frequently provides a source for advancement in rating examination questions. NavAir 10-1TB-62 is a ready reference table of publications and instructions applicable to naval photography and should be retained in the photographic lab to be used as necessary.

NAVY STOCK LIST OF FORMS AND PUBLICATIONS

The Navy Stock List of Forms and Publications, Cognizance Symbol I, NavSup Publication 2002, lists technical publications and forms available to naval aviation activities.

The forms and publications stock lists contain a complete numerical listing of all available naval aeronautical publications distributed by the Naval Air Systems Command and stocked for issue as of the date of the publication.

Publications dealing primarily with the operation and maintenance of aircraft and related equipment within the Naval Establishment emanate from Naval Air Systems Command. Publications concerned mainly with the training of flight personnel and air operations emanate from DCNO (AIR). Both types of publications are normally distributed by Naval Air Systems Command.

The forms and publications stock list is revised periodically by the issuance of supplements. The supplements are organized in the same manner as the basic list; thus, new publications or revisions to old ones are easily located and identified.

The forms and publications stock lists are the basic guide as to what is current in the way of photographic publications, and should be checked frequently, along with the supplements issued thereto.

PERSONNEL RECORDS

To most supervisors, maintaining records of any kind seems to be the most difficult part of office routine. One of the most important and time consuming records is on personnel. In addition to the records of on-the-job and in-service training there are other personnel records which should be kept, in order that you may perform the supervisory aspects of your job. One of these records is an individual data card which may also serve as part of the Division Officer's Notebook. This card is usually filled out when the man reports aboard and includes such information as name, service number, date of rate, date next eligible for advancement, educational background, hobbies, and other such information that will give you a better insight into the man's personality and background. Later entries of correspondence courses completed, off-duty education, and other date of special interest can be added during the man's tour of duty at your station. NavPers Form 2840, Division Officer's Personnel Record Form, can be used for this purpose.

If desired, a personal data file can be set up on each man to keep a running record of items of special interest to you and the division officer. Such information would be invaluable in assisting you, the supervisor, in making a better evaluation of the man's performance of his duty during that particular period. Many supervisors are prone to remember the man's performance in the last few days or weeks preceding his evaluation and are likely to overlook noteworthy things which occurred early in the evaluation period. Remember, when making up an evaluation sheet, that it is an evaluation over several months rather than just a short period. It behooves the supervisor to look for all means whereby all of the facts pertaining to the evaluation period can be reviewed to give the man an impartial, objective evaluation.

FILING

No activity can be operated efficiently without the smooth flow of paperwork. An adequate filing system is not only important–it is essential. The main objective of any filing system is to insure ready location of any correspondence with a minimum amount of effort and loss of time. As a leading petty officer of a photographic laboratory, the First Class or Chief Photographer's Mate is responsible for establishing and maintaining an adequate filing system.

Setting Up a File

The following are main factors contributing to the establishment of an efficient filing system:

1. Organization of a correct system.
2. Setting up correct file subjects in folders.
3. Correct classification of all incoming and outgoing correspondence.
4. Modification of the system as required.
5. Thorough indoctrination of personnel maintaining the file. With a filing system correctly established, it is possible for anyone with a general knowledge of the Navy filing system to locate a particular piece of correspondence speedly and conveniently.

Navy Filing System

The Navy filing system (used by the entire Navy) is the Standard Subject Classification System for the filing of records, correspondence, and other documents. This system is set forth in SecNav Instruction 5211.3 (Series).

The standard subject classification numbers (contained in SecNav Instruction 5210.11 (Series)) used in the Navy for filing all correspondence and directives consists of 13 major subject groups. Each of these major subject groups is designated by a 4- or 5- digit numeric code. These major subject groups are as follows:

1000 Series	Military Personnel
2000 Series	Communications
3000 Series	Operation and Readiness
4000 Series	Logistics
5000 Series	General Administration and Management
6000 Series	Medicine and Surgery
7000 Series	Financial Management
8000 Series	Ordnance Material
9000 Series	Ships Design and Ships Material
10000 Series	General Material
11000 Series	Facilities and Activities Ashore
12000 Series	Civilian Personnel
13000 Series	Aeronautical Material

Small activities may adapt this sytem to their needs by preparing file folders for a minimum number of major subjects and arranging material within these folders according to the classification number assigned. Files may be expanded by adding more file folders as required. The file numbers originally assigned to the records will remain pertinent and need not be changed; this makes expansion logical and easy. Large activities may adapt this filing system to their needs by preparing folders not only for the major subject groups but also for the primary and secondary groups.

Additional information pertaining to classifying and filing correspondence and other documents by subjects may be found in SecNav Instruction 5211.3 (Series).

NAVY CORRESPONDENCE MANUAL

The Navy Correspondence Manual prescribes policies and outlines procedures for the preparation of correspondence in the Department of the Navy. These policies and procedures are followed unless prescribed otherwise by the Secretary of the Navy or by his authority.

The selection of the proper communication for use in transmitting information is of special importance in Navy operations. Listed below are some of the types of correspondence and their uses:

1. Naval Letter. The naval letter is used by all activities of the Department of the Navy as a formal means of intranaval communication. It may be used also in addressing other agencies, either governmental or nongovernmental, which are familiar with the style. (See fig. 2-4.)
2. Joint Letter. When officials of two or more activities need to issue a letter concerning a particular subject of common interest to the activities, a joint letter is prepared. It may be directed to one addressee, or to two or more addresses identified spearately or as a group.
3. Speedletter. A speedletter is a form of naval correspondence used for urgent communication which does not require electrical transmission. It is not used for directives. The primary purpose of the speedletter is to call attention to the communication, so that it will be handled as promptly as possible by the recipient.
4. Memorandum. A memorandum is a form of naval correspondence used for informal communications within and between headquarters components of the Navy Department, between fleet and force commanders and units of command under their jurisdiction, and within a field activity. It may be directed to one or more addressees.

The naval letter is perhaps the most formal type of correspondence used by the Navy, but this does not mean that its content cannot be simple. Avoid long sentences and long words where short sentences and short words convey the same meaning. Each paragraph should contain one complete thought expressed in logical sequence. Tables, diagrams, and sketches should be i[illegible]ded as enclosures if necessary to add to the c[illegible]y of the letter.

If the letter is in reply to another letter, it should answer all expressed and implied questions.

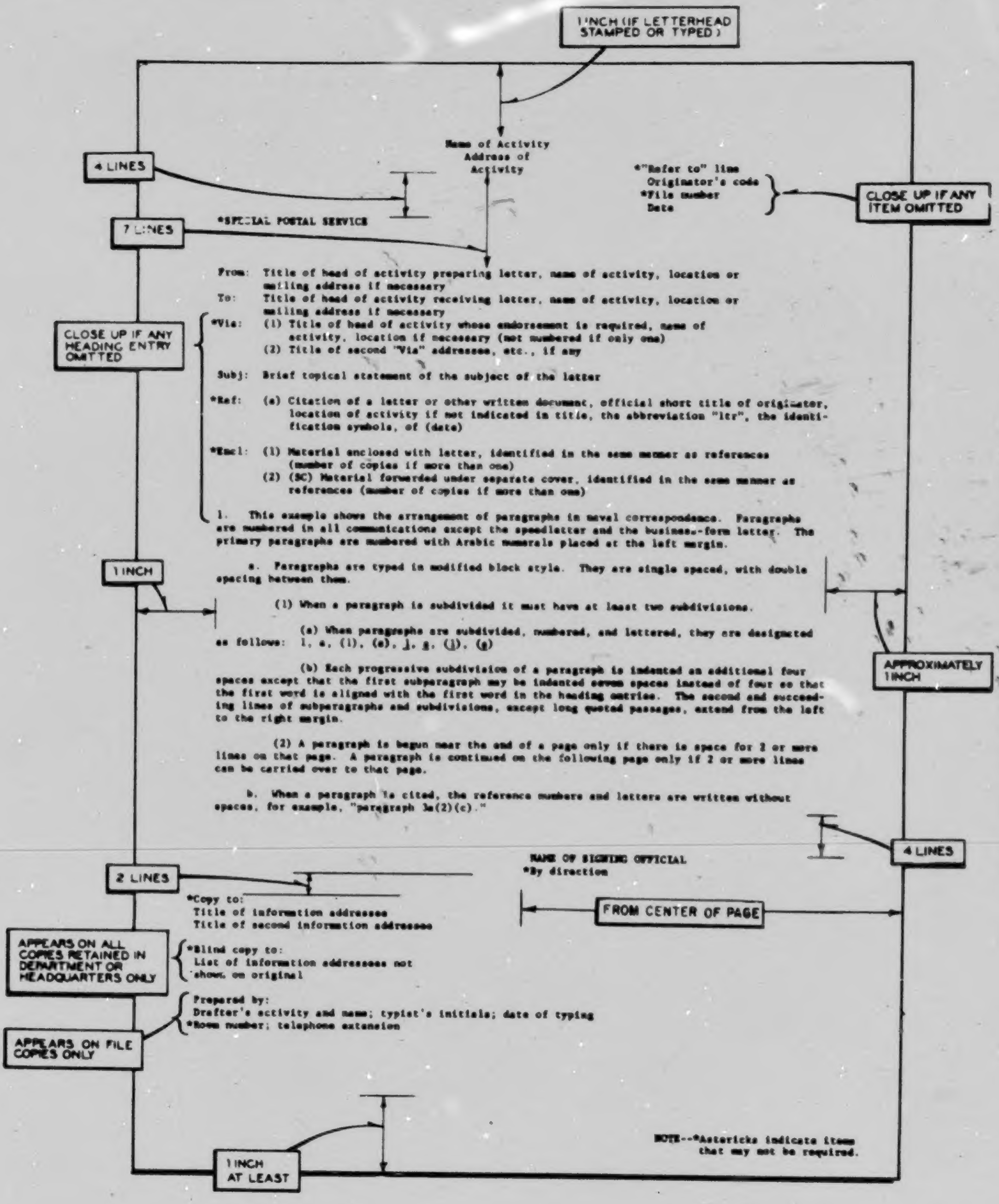
Classified Files

Classified files are files containing classified material and are usually centralized within an activity. "Classified Material" is any matter, document, product, or substance on or in which classified information is recorded or embodied. "Classified Information" is official information which has been determined to require, in the interest of national defense, protection against unauthorized disclosure and which has been so designated.

Classified files in a photographic laboratory may contain negatives, prints, job orders, data sheets, logs, and correspondence. Only designated, authorized personnel on a "need to know" basis should have access to these files. Classified files should be handled and safeguarded in accordance with U.S. Navy Security Manual for Classified Matter, OpNav Instruction 5510.1 (Series).

Report Tickler File

Although the number of reports required of the photographic laboratory is usually small compared to the departmental reports, it is frequently desirable to maintain a reports tickler file to insure that reports are prepared correctly for submission on due dates. This system provides a master reports tickler file of all



1 INCH (IF LETTERHEAD STAMPED OR TYPED)
4 LINES
7 LINES
CLOSE UP IF ANY ITEM OMITTED
CLOSE UP IF ANY HEADING ENTRY OMITTED
1 INCH
APPROXIMATELY 1 INCH
4 LINES
2 LINES
FROM CENTER OF PAGE
APPEARS ON ALL COPIES RETAINED IN DEPARTMENT OR HEADQUARTERS ONLY
APPEARS ON FILE COPIES ONLY
1 INCH AT LEAST

Name of Activity
Address of
Activity

*"Refer to" line
Originator's code
*File number
Date

*SPECIAL POSTAL SERVICE

From: Title of head of activity preparing letter, name of activity, location or mailing address if necessary
To: Title of head of activity receiving letter, name of activity, location or mailing address if necessary
*Via: (1) Title of head of activity whose endorsement is required, name of activity, location if necessary (not numbered if only one)
(2) Title of second "Via" addressee, etc., if any

Subj: Brief topical statement of the subject of the letter

*Ref: (a) Citation of a letter or other written document, official short title of originator, location of activity if not indicated in title, the abbreviation "ltr", the identification symbols, of (date)

*Encl: (1) Material enclosed with letter, identified in the same manner as references (number of copies if more than one)
(2) (SC) Material forwarded under separate cover, identified in the same manner as references (number of copies if more than one)

1. This example shows the arrangement of paragraphs in naval correspondence. Paragraphs are numbered in all communications except the speedletter and the business-form letter. The primary paragraphs are numbered with Arabic numerals placed at the left margin.

a. Paragraphs are typed in modified block style. They are single spaced, with double spacing between them.

(1) When a paragraph is subdivided it must have at least two subdivisions.

(a) When paragraphs are subdivided, numbered, and lettered, they are designated as follows: 1, a, (1), (a), 1, a, (1), (a)

(b) Each progressive subdivision of a paragraph is indented an additional four spaces except that the first subparagraph may be indented seven spaces instead of four so that the first word is aligned with the first word in the heading entries. The second and succeeding lines of subparagraphs and subdivisions, except long quoted passages, extend from the left to the right margin.

(2) A paragraph is begun near the end of a page only if there is space for 2 or more lines on that page. A paragraph is continued on the following page only if 2 or more lines can be carried over to that page.

b. When a paragraph is cited, the reference numbers and letters are written without spaces, for example, "paragraph 1a(2)(c)."

NAME OF SIGNING OFFICIAL
*By direction

*Copy to:
Title of information addressee
Title of second information addressee

*Blind copy to:
List of information addressees not shown on original

Prepared by:
Drafter's activity and name; typist's initials; date of typing
*Room number; telephone extension

NOTE--*Astericks indicate items that may not be required.

AG.379

Figure 2-4.—Format of a naval letter.

reports required by the photographic laboratory. Each card in the file contains such items as the report's symbol, title of the report, requiring directive, action office, prepared by, signed by, and distribution of copies. The files are set up by due date and require daily attention.

NAVY DIRECTIVES SYSTEM

Directives are written communications or issuances by the various bureaus and offices of the Navy Department and activities within the Naval Establishment which (1) prescribe or establish policy, organization, methods, or procedures; (2) require action; or (3) contain information essential to the effective administration or operation of the activities concerned.

The Navy Directives System, which provides a uniform plan for issuing and maintaining directives, uses two types of directives as follows:

1. Instructions. Instructions are directives of a continuing nature and are effective until subsequently canceled or superseded by the originator.
2. Notices. Notices are directives of a one-time nature or directives which are applicable for a brief period of time (usually 6 months or less). Each notice contains a provision for its own cancellation for which a specific date is stated for record purposes.

SecNav Instruction 5215.1 (Series) sets forth the standards for this system. The most significant benefits derived are listed below:

1. The Navy-wide use enables each activity which receives directives to do the following:
   a. Effectively group the directives on any specific subject and relate directives on the same subject with other materials.
   b. Have an easy method for filing directives and describing them as references.
   c. Differentiate between directives of a continuing nature and those of brief duration.
   d. Obtain copies of instructions to replace lost or damaged copies, or obtain complete sets of instructions upon reactivation or commissioning.
   e. Determine periodically, by use of checklists, the current status and the completeness of its set of directives.
   f. Determine by the use of subject indexes what directives are in effect on a subject.
2. Each naval activity which issues directives is able to proceed as follows:
   a. Reduce the number of directives in effect by systematically consolidating instructions which cover the same subject, by eliminating instructions which duplicate, overlap, or conflict, and by promptly canceling obsolete directives.
   b. Improve the adequacy and coverage of instructions and identify gaps in policy and procedures so that directives can be issued to cover necessary subjects.
   c. Eliminate duplicate writing, printing, and distributing operations.
   d. Insure that recipients are sent only those directives which pertain to their operations.
   e. Improve general administration by using a uniform system which includes reference aids for recipients of directives.

Alphabetical Subject Indexes

The Navy Directives System, Consolidated Subject Index, (NavPub Instruction 5215.4 (Series)), listing unclassified instructions originating in various bureaus and offices and promulgated by the Navy Publications and Printing Service is issued on 30 June. (Quarterly supplements are also issued). This index assists addressees in identifying departmentally originated instructions on any desired subject. Each current edition provides an alphabetical guide to the subject matter of all unclassified instructions by components of the Navy Department.

Directives issued by components of the Navy Department are addressed to many different distribution lists. Therefore, no specific activity receives all the instructions included in this Index. However, since originators determine distribution on a need-to-know basis, each activity receives or should receive instructions on subjects with which it is concerned. An activity may determine whether it was an addressee on a particular instruction by referring to NavPub Instruction 5215.3 (Series), the Navy Directives System, Consolidated Check List.

Numerical Checklists

The Consolidated Check list is prepared annually on 30 June and should be retained for use in conjunction with subsequent quarterly supplements. These numerical checklists are issued to only those units and facilities listed in Part 1 and Part 2 of the Standard Navy Distribution List (SNDL) in checking their master sets of instructions. Checklists cannot be used by activities not maintaining the master set of directive binders for the cognizant command.

Standard Navy Distribution List

The Standard Navy Distribution List is published to provide for the proper addressing and distribution of mail to all activities of the Naval Establishment, and to provide a condensed procedure for permitting circular distribution of correspondence.

The Standard Navy Distribution List is published in two parts. Part 1 is a confidential, nonregistered publication entitled Standard Navy Distribution List (Operating Forces of the Navy and Unified Commands), OpNav P09B23-107. The Catalog of Naval Store Activities, OpNav P213-105, constitutes Part 2 of the SNDL. This part (nonregistered and unclassified) contains the official list of shore activities of the Naval Establishment. The term "shore activities of the Naval Establishment" includes activities of the Shore Establishment and shore activities assigned to the Operating Forces.

SUPERVISION

Supervision is being responsible for and directing the work of others. As you advance in rating, more of your work becomes a matter of supervision and training others in the performance of the various functions of the photographic laboratory. Your value to the organization will be measured largely in terms of the quantity and quality of the work of your subordinates. This does not mean that everything can be delegated to subordinates, as there will continue to be tasks and responsibilities that you must take care of yourself. However, you must not take the attitude that it is easier to do the work yourself than to train and supervise somebody else. In supervising your subordinates you will need to have certain skills and knowledge.

SKILL IN LEADING

Here is where you should excel. Lead the men that you are coaching; do not drive them. Set examples for them to follow. Know them as individuals and handle their problems individually. Reprimand them in private; praise them in public. The men will work for you and their training will be more easily accomplished and more effective if you can learn to do the following:

1. Be predictable and consistent in your dealings with them.
2. Project to your men the enthusiasm you feel for the work they are doing.
3. Have no fear of your position, your boss, the people you are supervising, any tough jobs, or honest mistakes.

This is not an all-inclusive list of things that will make you a leader of men overnight. These items are sound, basic principles which, when mixed well with commonsense, will improve your leadership abilities.

SKILL IN ORGANIZING

Organization is a form of discipline which, if carefully accomplished, can contribute substantially to successful supervision. An important element of good organization is the delegation of AUTHORITY and RESPONSIBILITY, which must always go together. Many individuals are reluctant to delegate authority because they fear the possibility of being embarrassed by the acts of their subordinates. These fears are generally an indication of a feeling of insecurity on the part of the supervisor. This insecure feeling can best be overcome by training the subordinates to increase their capacity for accepting responsibility and authority.

Not only do supervisors sometimes fail to delegate authority, but they also frequently fail to delegate properly the work that needs to be done. A supervisor can very readily handicap himself by trying to do more than he needs to do. The result is that he becomes an ineffective supervisor and leader.

KNOWLEDGE REQUIRED

Successful supervision demands a vast amount of knowledge. The wide variety and complexity of jobs require the supervisor to have considerable technical knowledge. It is almost inevitable, however, that the supervisor will be given some tasks for which his training and experience are inadequate. In these situations the supervisor must be dependent upon the knowledge and abilities of others, and upon his own leadership.

The supervisor must have a knowledge of the overall objectives of the organization of which he is a part. In addition, he needs to have a clear understanding of the specific part his own group must play in attaining the basic goals. His planning, organization, directing, and in fact, all problem solving, should be done with both the general and specific aims of the organization clearly in mind.

KNOWLEDGE OF MEN AS INDIVIDUALS

Of paramount importance to a successful supervisor is a thorough knowledge of subordinates as individuals. The supervisor needs to be continuously aware of the fact that individual differences do exist and that they cannot be overlooked.

It is particularly dangerous for a supervisor to fall into the habit of stereotyping people.

SKILL IN THE COMMUNICATION OF IDEAS

Another skill which is required of a good supervisor is skill in the communication of ideas. This is essential in giving orders, in the dissemination of information, and in training or teaching. In the Navy, the channels for communication and the lines of authority are the same. These channels should not be bypassed. If one's subordinates are expected to function willingly and cooperatively, they should be given all the information they need or can use.

SKILL IN INSTRUCTING

You must develop skill in imparting your knowledge to trainees on how the job is to be done. The apprentice is depending on you to demonstrate and coach him in the correct procedures and methods to be used. As the trainee progresses from one work experience to another, you will be guiding and coaching him. To assist you in developing skill in instructing, keep the following in mind:

1. Show your new man how to do the job without showing off or showing him up.
2. Have all the answers you can, admit it when you do not, and get him the correct answer as soon as possible.
3. Learn to be sincerely interested in others.
4. Keep your sense of humor.
5. Be patient.
6. Be sure the trainee understands what the job is and how it is to be done.

PROBLEM SOLVING

The practical exercise of supervision (or leadership) is largely concerned with problem solving. Every day new problems are encountered; there may be difficulties different from any you have ever met. If you can look at these difficulties briefly, and then, almost without pause, see and apply a sound solution, you are fortunate. Indeed, you are exceptional; for most of us must cautiously examine difficult problems and weigh the solutions carefully. Even then we are subject to serious errors if we overlook some of the details which are not too obvious.

If all of us were to go about solving problems in exactly the same manner, we would necessarily have exactly the same thought processes. Although we do not think alike, all those who are capable of finding proper solutions quickly and easily do have something in common. They follow a fairly well established pattern of thought and action.

Some people practice the pattern instinctively, thereby reaching solid, useful conclusions in what appears to be an amazingly short time. For most of us, this pattern is not one we know instinctively. We learn it only after having exerted concerted effort. We may learn of it in the classroom, on the job, or from books, but it becomes a habit only after the trial and error of repeated application.

Techniques in Problem Solving

The problem solving process may be divided into six steps. Individual leaders go through these steps either deliberately or automatically.

Preliminary to solving a problem, you must recognize that there is an actual problem to be solved. Then proceed as follows:

1. Define the problem.
2. Establish objectives; determine specifically what you want to accomplish.
3. Get the facts. Assemble all the facts pertinent to the problem. Ascertain what personnel, if any, are involved. Review the record. Find out what rules, regulations, and customs apply. Contact the individual concerned for opinions and feelings, as well as facts. Be sure you have the whole story. Perhaps materials or equipment constitute a part of the problem. Methods or operational schedules may also affect the problem.
4. Weigh and decide. After all the facts have been assembled, analyze the problem in light of the facts. Fit the facts together and consider their bearing on each other. Check regulations, policies, and practices. What possible actions are there? What are the possible results of each action? Choose the best action without unnecessary delay, but do not made sudden or hasty conclusions.
5. Take action. First consider the following questions: Should I handle this problem myself? Do I need any help in handling it? Then consider the proper time and place to take the action that appears most likely to solve the problem. Do not depend on someone else to solve the problem.
6. Evaluate the action. In this step, check the results of your action to see if it solved the problem. Never just assume that the problem was solved, as you may find that the action brought about additional problems instead of solving the initial problem. Watch for changes in output, attitudes, and relationships. If the problem was not solved, you may need to gather more facts and go through the entire problem solving procedure again.

The problem solving technique can be mastered by any individual who is capable of learning. It may seem to take a great deal of time, but eventually it will actually save time. The individual who desires to become a good supervisor should beccome so skilled in its use that this technique is used automatically when dealing with the problems of supervision.

TRAINING

Training of photographic personnel is a continuing process. Attending one of the schools which have been established for the training of Photographer's Mates is only the first step. The schools give the men a good working knowledge and broad theoretical background in photography, but nothing can take the place of on-the-job training and the training program carried on by operating units.

There are several fundamental reasons for having a continuous training program. New items of equipment are being made available to operating units. New procedures and techniques are being developed. New men are coming into each organization with varied backgrounds. Retraining of present personnel is sometimes necessary. Training for advancement in rating and safety training are needed by all the men.

It is necessary to determine just what training is most needed and will be most beneficial for the personnel. This is a task that requires a thorough knowledge of the men involved, their strong points and their weaknesses, as well as a knowledge of the specific duties and skills required of their rating. The objective must be to bring each man up to the point of maximum efficiency in his present rate, and to prepare him for advancement in rating. At the outset, therefore, in the planning of a training program there should be a clear conception of the purposes that the program is to serve. When this understanding is lacking, a determination cannot be made as to what materials will be utilized, what educational approach to use, and what teaching methods will best suit the matter to be learned.

Since a training program worthy of the name means a great deal more than just hit-or-miss training gained from experience in performing various jobs, due consideration must be given to the instructors, the trainees, the subject matter to be taught, the training materials, the method of teaching, and testing.

INSTRUCTOR

Instructing is one of the principal duties performed by petty officers. It will certainly be one of your jobs as a senior Photographer's Mate. The role of instructing is not new to you, since you are instructing every time you teach a subordinate how to perform some photographic or military duty.

For further information on your job as instructor, as well as on the other aspects of the training function of a petty officer, see the appropriate sections in Military Requirements for Petty Officer 1 & C, NavPers 10057-B, concerning the responsibilities of the petty officers for training.

TRAINEES AND SUBJECT MATTER

Your trainees will be the strikers and the junior Photographer's Mates. You have to find out what sort of persons they are, and what they already know and do not know.

The subject matter is the skill or knowledge the trainee is to learn. Knowledge is familiarity with facts, persons, and things. A skill is the acquired ability to do something with ease, precision, and accuracy. What you are to teach your men will be prescribed by the "Quals" Manual and your activity's training program.

LESSON PLAN

A lesson plan is a guide for an instructor to follow in his presentation of a unit of instruction. Lesson plan formats vary, according to the degree of formality of the instruction situation, type of training, and local conditions. Suggestions for parts of a lesson plan are as follows:

1. Includes the title or subject matter of the lesson.
2. What the lesson is designed to accomplish.
3. Explanation of the topic to create interest and thinking of the trainee.
4. An outline of the subject and notes as to the method of presentation.
5. Covers the most important points of the lesson.

For additional information on lesson planning consult the Manual for Navy Instructors, NavPers 16103-C.

TRAINING SYLLABUS

A training syllabus or outline is prepared with content and scope corresponding with practical factor requirements of the personnel. On-the-job training is recorded by the leading petty officer instructors so that a close watch may be made on individuals progress. The records are for review by higher authority and will point out the need for training in special areas.

TRAINING SCHEDULE

A schedule of training is prepared and published in advance of the planned training for any particular period. It may be daily, weekly, or monthly depending on the local conditions. It lists the subject, name of the instructor, date and time, location of the training, and names of the men who are to attend.

TESTING

The overall effectiveness of a training program will be indicated by the proficiency with which the trainees perform their various tasks, by the demonstration of their understanding of the subject matter field, and by the showing they make on fleetwide rating examinations. However, the instructor needs more definite yardsticks for the evaluation of a training period or a particular training program. These yardsticks will be the oral, written, and performance tests that the instructor will give as needed. Both written and performance tests are given consideration, but bear in mind there is no set way to construct them. Testing is covered in Military Requirements for Petty Officer 1 & C, NavPers 10057-B.

ETHICS IN LABORATORY PROCEDURE

In an organization where men work together as a team there must be a "right way" to do things, or a CODE OF ETHICS—a way of performing duties which will serve to maintain the best possible personnel relations, and at the same time keep the quality of work at the highest possible level.

In a military organization a happy crew is, as a rule, an efficient crew. Training a crew, keeping them informed of what is going on, and requiring them to work in an approved and harmonious manner will improve work efficiency a hundred fold and, at the same time, maintain morale at a satisfactory level.

In order to clearly understand the meaning of professional ethics it is defined in accordance with Webster's New Collegiate Dictionary. "Ethics are a treatise on morals, the science of moral duty; broadly, the science of ideal human character." The professionally ethical individual conforms to professional standards of conduct.

In any commercial organization engaged in photographic work, it is necessary to operate in accordance with the accepted professional code of ethics in order to maintain a profitable enterprise. This means that all dealings with other workers in the profession, fellow workers in the organization, and the general public must be conducted on a level of "good will." A reputation for honesty and integrity in all dealings with these people is a major requisite for the successful operation of a business interested in profitmaking.

Operating in accordance with recognized and approved standards is just as important in a naval photographic unit as it is in operating any commercial photographic organization. In the Navy, the conformance to a code of ethics can more easily be disregarded (and sometimes is) because the continued existence of the organization is not solely dependent on the quality of its work or on its personnel's relationships with others. However, high efficiency and smooth operation cannot exist if cooperation, consideration, and understanding are not deeply rooted within the organization.

The encouragement of these character traits among the men is the personal responsibility of the officers and senior petty officers charged with the leadership of military men. Four important items to be considered under the heading of moral leadership are as follows:

1. Personnel relations within the unit.
2. Interdepartmental relations.
3. Efficiency and orderliness in the laboratory.
4. Military proficiency and smartness.

PERSONNEL RELATIONS WITHIN THE UNIT

The unit that is organized in such a way that friction between its members is minimized or nonexistent will be an efficient organization. The development of professional pride as well as pride of service is one of the prime duties of the leading petty officers. To extract this feeling from crewmembers, petty officers must display in themselves those basic qualities of character which make a man proud of his achievements and of belonging to the organization.

It is important that petty officers always remain aware of the fact that, like any civilian society, the Navy has all types of personalities in it. Thus, a willingness to understand and guide the many different individuals with whom they come in contact, is an absolute prerequisite for advancement to the top of the ladder. The petty officer must know his men, their good points, along with the limitations of each. He must develop a personal and professional relationship with each crewmember under his charge. The reward for this interest is respect, not only for his professional competence, but for his honest and integrity as well.

Problems and arguments arise when groups of people are working closely together. One of the most important traits of leadership in a petty officer is his ability to solve unpleasant situations quickly, fairly and intelligently. An atmosphere of malice, contempt and hate should never be allowed to exist among crews, because these distasteful traits quickly lead to the most serious kind of discord.

EFFICIENCY AND ORDERLINESS IN THE LABORATORIES

The efficiency of a unit is directly reflected in the everyday appearance of the unit, not just in the way it appears during scheduled inspections. If spaces and equipment are clean and orderly during and after working hours, one can be assured that this efficiency will extend to the finished work of the organization.

Clean spaces in a photographic laboratory usually mean better working conditions and better quality work. Petty officers should stress and emphasize the importance of individual cleanliness and neatness in performing the various laboratory assignments, as well as in the maintenance of working spaces and equipment.

MILITARY PROFICIENCY AND SMARTNESS

There is never an end to the fundamental training of military personnel. A crew that takes an interest in the professional quality of laboratory work is usually an enthusiastic group of individuals who also have a concerned interest in their personal dress and military obligations. Leading petty officers are required to instruct younger men in these phases of military life. Neatness of personnel and their observance of uniform regulations and courtesy are marks of an efficient unit.

ETHICAL PRACTICES IN RELATION TO CIVIL LAW

Ethical practices extend further than the principles of human conduct. Disregard of ethical practices in the field of photographic endeavor can plunge the uninformed photographer into situations which could feasibly amount to a gross violation of the legal rights of man.

The camera, like the professional writer's words, is a powerful means of disseminating and commercializing the personality for news, publicity, advertising, etc. Consequently, in dealing with the human personality, it is possible either in the taking or printing of a picture, to become involved in a serious civil lawsuit.

In the Navy, it is logical to assume that Navy photographic personnel have been thoroughly indoctrinated in the aspects of law and photographs, but all too often this assumption is without basis. What is closer to fact is that the Navy photographer has a vague notion of what he can shoot and what he cannot shoot, or what he can print and cannot print.

The Photographer's Mates First Class and the Chief Photographer's Mates are described in photographic circles as professionals, and naturally are expected to be aware (to some degree) of the ethical and legal aspects of the profession. However, whether one is an amatuer or a professional photographer, a basic insight into the law of personality and the commercial rights regarding photographs is an absolute necessity for everyone who chooses to use a camera.

LEGAL RISKS AND RIGHTS

Picture taking falls into two categories insofar as the law is concerned: (1) the risks involved and (2) the rights created. This is applied to photographs in the following manner. The photographer wishes to avoid the risk of a lawsuit initiated by those he photographs, before or after the picture is published. The publisher, on the other hand, wishes to avoid similar risks which can result from publication of photographs. The photographer is further concerned with certain rights to which he is entitled. For instance, the right to profit from his work, or the right to retain control of his photographs for future profit. Likewise, publishers as buyers of photographs have similar considerations under the law. Exclusive rights to photographs may become theirs through purchase, or "one-time-use" may be a right they can acquire through the initiation of written transactions with the photographer.

The subject of copyrights, tangible property rights and intangible rights to profits in the sale and purchase of photographs covers an extremely wide, technical and complicated area for discussion. Naval photography is not concerned with the commercial sale of photographs, thereby eliminating the possibility of legal involvement insofar as risks and rights relative to profits are concerned. However, the Navy is concerned with its photographers' dealings in the area of the legal risk associated with the invasion of privacy, and the violation of the legal concepts which have been set down concerning copyright as a property and a risk.

PRINCIPLES OF PRIVACY

The right of privacy as involved in law, is designed to protect individuals from damage to their reputations through false statements. In the matter of taking pictures, the right of privacy goes a step further in favor of the individual. It states that everyone has the right

NOT to have his picture published, or his name and personality publicized without his written consent, except where the public interest or need intervenes. An example of this exception would be the publication of a picture of an individual without his consent by newspapers or magazines purely for the purpose of reporting a news story. The right of privacy is not violated here because we have a free press in this country. However, the right of privacy is violated if the picture is used for advertising purposes or for illustrating a factual or fictional article for which the writer has been paid. In other words, whether or not the publication of a picture violates the privacy of an individual will depend a great deal upon the content and nature of the text of the story accompanying it, and whether there is profit involved.

Limits of Privacy

Determining the exact limits of privacy is usually dependent upon the points at which public need or interest begins and ends. Relative to the law, this poses many problems, and judicial decisions on that point have been varied in many of the courts. The general rule, however, has been to rule in favor of one who has had a photograph published for trade or commercial purposes without his written consent. In most cases that has constituted a violation of the rights of privacy.

To decide when an individual is or is not a public character is also a matter of extreme importance. For, in the handing down of decisions, the fact that an individual has chosen to become a public figure, will influence the judgment. For instance, if one holds the position of public office, or if a person has become involved in the commission of a crime, in most instances he cannot successfully assert his right of privacy. By being a public office holder, a public character, or by committing a crime, an individual automatically places himself in a position whereby the public interest is greater than his right to privacy.

There are times in the course of reporting news events that the photographer can be liable in a lawsuit involving a violation of the right of privacy laws. Not only the private-citizen but the public figure as well, can recover damages if news pictures tend to grossly ridicule, horrify or sensationalize to the extreme. Records show that lawsuits against news publications have been ruled on in the past, in favor of the victims or their heirs. Thus, a general rule of thumb to follow in order to steer clear of this type of involvement while photographing spectacular or unusual news events is: (1) use common sense, (2) exercise good taste, (3) consider the emotions and feelings of the person photographed or surviving relatives.

Photographic Libel

Libel may be defined as recorded defamation of character either by words or pictures. That is, an individual is defamed when his good name and reputation are damaged by depicting him in such a way that he may be hated, ridiculed or held in contempt. The absolute defense in a defamation case is the question of TRUTH. For instance, if a so-called libelous picture is proved to be true representation of fact, no libel is involved. It is good to remember that in the defense of an invasion of privacy violation, truth is not the issue to be considered. Libel resulting from the publication or taking of photographs rarely ever occurs; the risk generally lies in the area of the right of privacy.

COPYRIGHT AND REPRODUCTION REGULATIONS

The rights granted by the law in the case of photographs are numerous as well as involved. A few of the basic regulations concerning copyrights are discussed here.

A photographer first has a property right in that the photographs taken by him as a photographer physicially belong to him. However, a more important fact is that he also has another right associated with his photograph, and that is an intangible right. This means that he has an inherent right as the originator or maker of the picture. The artistic skill and mental effort applied to produce the photograph is that which is protected under the law. This additional right, the one most often violated by the uninformed, is defined as a COPYRIGHT.

FEDERAL COPYRIGHT LAWS

The photographer's intangible right is so important that it is protected by a clause in the Federal Constitution and by the Federal Government (U.S. Constitution, Article One, Section 8). Under this power, Congress enacted a Copyright Statute (U.S.C.A. 17).

This Copyright Act specifically restricts the use, without written permission, of one's mental labors and in the case of photographic efforts, four kinds of copyrights apply. They are as follows:

1. Common law copyrights.
2. Statutory copyrights on unpublished pictures.
3. Statutory copyright on published pictures.
4. International copyright protection.

The common law copyright, which applies to any picture until it is published, is given automatically by the law. The photographer does not have to file for this protection. If a picture is never published, it will always remain copyrighted by the photographer.

The statutory copyright on unpublished pictures gives substantially the same protection as the common law copyright. By formally registering an unpublished picture with the Copyright Office, a greater degree of protection is apt to result under the Federal statute.

The statutory copyright on published pictures is the protection that preserves the property right for published pictures. This copyright is generally obtained upon publication and it is the only real protection available on published pictures.

The international copyright protection covers the photographer's works when published in certain foreign countries. International protection requires many detailed considerations. Including a discussion of these copyrights in this chapter is not practical; however, further information may be obtained from the Copyright Office in Washington.

The all important point to remember in regard to the publication of photographs is that the rightful owner of the picture has certain personal rights which are specifically protected under the law. Thus, in dealing with photographs which are known to belong to another, it is good to check first to ascertain who owns the property right. Second, insure that the photograph is not a violation of the right to privacy.

These inherent rights of the originator, spelled out in terms of just how much protection the photographer has under copyright law and common law precedents, are as follows:

1. The right to forbid copying (reproduction) of his photograph.
2. The right to sell his photograph outright.
3. The right to sell particular uses of his photograph.
4. The right to forbid exhibition of his photograph.
5. The right to enter suit in civil courts for any illegal or unauthorized use of his photograph.

In order to benefit by the protection the law offers regarding these rights, the photographer must meet the following conditions:

1. He must have taken the photograph in question himself.
2. He must have taken the photograph on his own time and not while employed by another photographer to take the photograph.
3. He must have taken the photograph with his own camera, or one rented or loaned to him.
4. He must have taken the photograph with his own materials.

VIOLATION OF THE FEDERAL COPYRIGHT LAWS

There are two separate misdemeanors under the Copyright Law of the United States by which infringement on a copyright holder's property may be punished. Paragraph 28 of this law provides:

> "That any person who wilfully or for profit shall infringe any copyright secured by this Act, and who shall knowingly and wilfully aid or abet such infringement, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by imprisonment for not exceeding a year or by fine of not less than one hundred dollars nor more than one thousand dollars, or both, in the discretion of the court. . . ."

Paragraph 29 of the law provides:

> "That any person who, with fraudulent intent, shall insert or impress any notice of copyright required by this Act, or words of the same purport in or upon any uncopyrighted article, or with fraudulent intent shall remove or alter the copyright notice upon any article duly copyrighted shall be guilty of a misdemeanor, punishable by a fine of not less than on hundred dollars and not more than one thousand dollars. . . ."

As pointed out earlier in this discussion, civil remedies include the right to an injunction and the right to sue for monetary redress. The copyright holder whose rights are infringed upon is entitled to recover damages suffered by him and also to recover profits made by the wrongful use of his property. (Copyright Statute U. S. C. A. 17.)

COPYRIGHT AND REPRODUCTION REGULATIONS IN THE NAVY

The previously discussed copyright regulations as they pertain to photography are reaffirmed in the United States Navy Regulations. The rights of copyright holders definitely restrict Navy persons from making use of copyright photographs without the written permission of the copyright holders.

Article 1265 of the United States Navy Regulations (1948) under the heading, "Adoption or Use of Proprietary Articles, Inventions, or Copyrighted Materials," states in part:

> ". . . no person in the Naval Establishment shall adopt or use or shall authorize the adoption or use for or on behalf of the Government of:
>
> 1. Any article when it is known to be proprietary.
> 2. Any invention when it is known, or there is reason to believe, that the invention is or will be patented.
> 3. Any matter in which it is known, or there is reason to believe, a copyright exists . . . unless consent of the owner has been obtained or, lacking consent of the owner, such use or adoption has been authorized by the Secretary of the Navy: Provided, however, that, adoption or use of any of the classes above mentioned may be made without waiting to obtain prior consent or authorization of either the owner or the Secretary of the Navy, but in any case where such adoption or use is made without obtaining prior consent or authorization, a full and complete report of all facts and circumstances relevent thereto shall be made promptly to the Secretary of the Navy."

REPRODUCTION OF NAVY PHOTOGRAPHS

Although the Navy Department itself does not copyright photographs, those produced by naval activities may not be used commercially unless they are released for publication. Releases are made through public information channels in accordance with instructions contained in the U.S. Navy Security Manual for Classified Matter.

If photographs of naval personnel are required for publication or for routine identification purposes, they should be produced originally by the facilities of naval photographic activities. If an official Navy publication wishes to use photographs of naval personnel produced by commercial parties, but paid for by the subject, an assurance must be made that the publication rights were not retained by the commercial photographer or that an official written release is available from the photographer.

UNLAWFUL PHOTOGRAPHY

Federal laws regulating photography are designed to prevent counterfeiting and fraud, and are found generally in title 18 of the United States Code, which covers crime. According to Section 489 of this Title (revised), coins and metals, issued as money, must not be photographed except for making plates to be used as illustrations in numismatic and historical books and journals, or in legitimate circulars issued by publishers of such works. Black-and-white illustrations of United States postage stamps may be photographed for philatelic purposes. Foreign stamps may be copied if the resulting illustrations are in black-and-white pictures only. According to Section 402.2, Title 31, Code of Federal Regulations, Black-and-white reproductions of canceled United States internal revenue stamps are permissable for legal purposes. The following list of items should never be photographed under any circumstances:

1. Money.
2. Securities, including certificate of indebtedness, bonds and bank notes.
3. Foreign currency.
4. Any other monetary instrument.
5. Postage stamps (actual size).
6. Citizenship certificates.
7. Bills of lading.
8. Copyrighted material.

The making of indecent or obscene photographs or the possession of them is, according to the United States Navy Regulations, a court martial offense as being scandalous conduct, or conduct to the prejudice of good order and discipline.

PHOTOGRAPHIC SAFETY

Accidents which occur in photographic laboratories are usually caused by carelessness or disregard of established, well-known safety rules. All dangerous equipment and materials should be handled with the caution and care their hazardous qualities require, to insure the safety of all personnel.

Safety Precautions for Photographic Personnel, NavWeps 10-1-764 contain safety precautions and instructions which must be observed and followed meticulously when handling equipment and photographic chemicals in photo laboratories aboard ship or at shore installations.

Safety is a command function and a responsibility of supervisory personnel who must see that safety precautions are rigidly adhered to in areas under their supervision. Each individual working in a photo laboratory is required to observe all safety precautions concerned with methods or techniques pertaining to his work or duty, and to report any hazardous situation, equipment, or material which needs attention. Each person working in a photographic laboratory is responsible for warning any other individual whom he believes to be endangered by apparent hazards or by failure to observe safety precautions. It is also the responsibility of each individual to observe all safety precautions and to protect himself by wearing or using protective clothing or equipment of the type approved for the safe performance of his work or duty.

It is the responsibility of the safety officer to determine procedures to prevent the occurrence of poisoning, burns, or other accidents in the photographic laboratory. Any emergency supplies required to provide quick and effective treatment along the lines established by the safety officer are in the charge of medical corps personnel. Provision for the availability of hand cleaners and wash areas is of critical concern.

Before photographic personnel handle or use photographic chemicals, they must become thoroughly familiar with the detailed precautions for their safe handling. This information and a list of dangerous photographic chemicals, their descriptions, and antidotes for external and internal application, are given in Safety Precautions for Photographic Personnel, Nav-Weps 10-1-764.

GENERAL SAFETY PRECAUTIONS

Photographic laboratory personnel must receive proper instruction in prescribed safety measures, must become fully aware of the need for adherence thereto, and always comply with them in all operations.

The following safety rules must be followed by personnel working in Navy photo lab areas:

1. Slow down when entering or leaving a dark space to eliminate the possibility of collision with anyone carrying an armload of glassware or a tray full of solution.
2. Operate a paper or print trimmer with extreme care, and always leave the blade down after each use. Stencil or otherwise mark the face of all trimmers with the following warning: LEAVE BLADE DOWN.
3. Do not lean on the glass of retouching tables, printers, or viewing tables, and avoid scoring their surfaces with a sharp cutting blade–under pressure, the glass could break and inflict serious lacerations.
4. Maintain scrupulous housekeeping practices in all areas where chemicals are handled.
5. Make acid type hand cleaners available in all areas where dangerous chemicals are

handled–in mix rooms, processing rooms, and other applicable lab areas.

6. Wash hands thoroughly with an acid type hand cleaner and rinse thoroughly with water immediately after handling poisonous chemicals, within minutes after possible exposure to their dust or fumes, and also several times a day when handling or using poisonous chemicals, even though no known contact has occurred.

7. Wash rubber gloves thoroughly and promptly with acid type hand cleaner and rinse well with water after each use, before removing gloves from hands.

8. Scrub rubber facepieces frequently with acid type hand cleaners, and rinse copiously with water.

9. Clean dust respirators thoroughly and frequently.

10. Launder work clothing frequently.

11. Provide adequate ventilation for processing rooms (in the ratio of 20 changes per hour).

12. Impress all maintenance personnel with the importance of avoiding skin contact with chemicals or chemically contaminated surfaces.

13. Store all chemicals in cool, dry, dark spaces. Separate storage areas are maintained for chemicals which react violently with each other, to diminish the danger of fire or explosion. (For example, do not store potassium permanganate near glycerin.)

14. Store corrosive chemicals on shelves strong enough to support their loads of containers and contents. These shelves should have copings or ledges, to prevent chemical containers and equipment from extending over the edges or from being shoved off the shelves.

15. Keep all corrosive chemicals in thick-walled glass containers protected by wooden frames or boxes. If the capacity of the container is 5 gallons or more, support the frame by a sturdy wooden or metal cradle, pivoted or hinged for ease in pouring.

16. Never smoke where volatile solvents are stored or used.

A great amount of photographic equipment is electrically operated. When working with or around such equipment, be alert to avoid any possible accident.

Inspect all electrical connections and wiring regularly for damaged, frayed, or broken insulation, and for possible short circuits.

Turn off all electrically operated equipment after it has been used. Some equipment–such as dry mounting presses–remain hot for some time after use. As soon as the heating elements in a press have been turned ON, place a plainly visible sign marked DANGER–HOT on the equipment, and leave it there until after the machine has been turned OFF and has had a chance to cool.

The following warning should be emphasized to all personnel.

WARNING: Never touch a plug, switch, or any part of an electrically operated machine with wet hands, or while standing in water, or on a wet deck. Be sure that hands are dry before touching such equipment. If the equipment should become wet, or be in possible contact with water while in use, disconnect the current before attempting to salvage the equipment. This applies especially to electric motors used with aerial film developers such as the Smith or Morse outfits.

Additional safety precautions on electrical and flash equipment are contained in NavWeps 10-1-764.

CHAPTER 3

SUPPLY AND ACCOUNTING PROCEDURES

One of your major responsibilities as a Photographer's Mate First Class or Chief is the responsibility for maintaining the photographic laboratory's supply status at an efficent operating level. The majority of the supply operations throughout the Navy are accomplished by the station's or ship's supply personnel as may be expected. However, these personnel cannot accurately anticipate the exact material and service needs of each activity. Thus, it is the responsibility of the senior Photographer's Mate to originate requests, perform proper inventories, and to insure proper utilization of materials within his particular activity.

To enable the leading Photographer's Mate to accomplish his administrative responsibilities with regard to supply, he must become familiar with the operation of the Defense Supply Agency, Navy Supply System, budgets, funding, requisitioning, accountability, and the inventory and proper maintenance of stock levels.

NAVY SUPPLY SYSTEM

The Navy supply system is composed of a group of activities which furnish most of the materials required by the Navy. Major end items are under the cognizance of the technical systems commands and hence fall outside the province of the supply system.

To insure efficiency in carrying out its assigned functions, the Navy supply system is organized into three basic elements: the Naval Supply Systems Command, the Navy inventory managers, and the distribution system.

NAVAL SUPPLY SYSTEMS COMMAND

The Naval Supply Systems Command provides supply-management guidance for the overall system. The Navy inventory managers are responsible for inventory management, procurement, and distribution within specific material areas. Each manager is assigned one area. The distribution system, which pertains to the actual storage, distribution, and issue of all material, reaches out to include the supply departments of all ships and stations.

NAVY INVENTORY MANAGERS

The Navy inventory managers control material within Navy stocks. If the material is of a common use nature and is under the overall control of the Defense Supply Agency, the Navy inventory manager coordinates procurement through the appropriate Defense Supply Center. If the material is peculiar to naval usuage, the Navy inventory manager handles central procurement from the contractors. Aviation Supply Office (ASO) and NavAirSysCom (AIR 539) are examples of Navy inventory managers.

SINGLE MANAGER CONCEPT

The single manager concept is the method used by the Department of Defense to procure commodities for use by all the armed forces. For example, all photographic materials carried in the Federal Supply System are procured by the Air Force.

DEFENSE SUPPLY AGENCY

The Secretary of Defense established the Defense Supply Agency to manage the procurement and distribution of common supplies, and to perform related services. DSA is the consolidated wholesaler for assigned items of supply and distributes to the depot level in the United

States. The military services determine requirements and, with the Joint Chiefs of Staff, establish priorities. DSA computes requirements, procures supplies from commercial sources, and sells to the services at cost plus surcharge for transportation. Reimbursements from customers replenish the Defense Stock Fund. It is the fund which provides the working capital for DSA procurement actions.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA), though not a part of the Department of Defense, does furnish some materials and services to the armed forces. It is responsible for supporting federal agencies for specific classes of materials or specific items within classes assigned to other inventory managers.

The General Services Administration maintains stock points at several locations throughout the country. It also has open-end contracts with major suppliers for such items as typewriters, adding machines, and calculators. A good portion of the Navy's administrative supplies and equipment are procured from this source.

The GSA system has an advantage in that annual contracts are made with nearly all manufacturers, and prices are established. Nearly all photographic materials used by the Navy are "on GSA Schedule," as it is called. This means that any local store, carrying material you need, will sell it to you at the established GSA price. However, material which is Navy stocked must be ordered from the Navy supply system. A comparison of prices varies; sometimes you will pay more ordering from Navy stock than you would pay through the GSA Schedule at your local store. The GSA "government prices" are generally 20 percent or more below the retail selling price. An example of items which would always be purchased "through the GSA Schedule" is Polaroid cameras, which are not stocked but all of which are on the GSA Schedule.

NAVAL AIR SYSTEMS COMMAND

The Photographic Division of the Naval Air Systems Command in the Navy Department is the technical command for photographic materials and equipment. Under the DOD Standards program, NavAir determines which items will be made standard and stocked by ASO, and which items are becoming obsolete and are to be taken off the shelf. NavAir is an engineering advisor to the Defense Supply Agency, and conducts an extensive research program for the development of new military items. When NavAir determines that a new item should be stocked, ASO is informed and given basic requirements and initial issue predictions. After that, ASO continues to replenish the stocks based on the issue rate. NavAir provides the funds to ASO for this stocking operation for 2R (APA) stocks.

After placing an item on the standard stocking list, NavAir also determines which activities can have the item in their photo labs, and then places the item on the applicable Allowance Lists. Computations from these lists determine the initial outfitting quantities required and ASO provides this information as part of its initial procurement requirements.

NavAir computes requirements for items of equipment which are bought for initial outfitting; directs initial issue, and controls further distribution. This class of equipment includes such items as color processors, aerial film processors, aerial cameras, etc. Although spares are sometimes stocked, there is no replenishment by ASO. These equipments are coded "2V Cognizance" in the catalogs and stock numbers.

AVIATION SUPPLY OFFICE

The Aviation Supply Office (ASO), located at 700 Robbins Avenue, Philadelphia, Pennsylvania, zip code 19111, is the inventory manager for aviation material. ASO is an agency under the joint control of the NavSupSysCom (for business management functions) and the NavAirSysCom (for technical management functions). This agency is the central nerve center of the aviation supply system and is assigned the responsibility for supply support of technical aeronautical material. As a Navy inventory manager, the primary job of ASO is to determine how much of each item to buy, when to buy, and distribution required to meet system demand.

Some functions of the Naval Supply Systems Command that are of interest to PH personnel are the general functions of ASO. These include the following:

1. Responsibilities for overall determination of requirements, procurement, and distribution of standard aeronautical materials. (Certain materials excepted; such as complete aircraft and engines, complete electronic equipment, major photo equipment, nonstandard and experimental aerological equipment, and items of naval weapons ordnance equipment.)
2. Maintenance of a complete file of ASO and Naval Air Systems Command contracts, letters of intent, amendments, and change orders, and distribution of all necessary copies of documents to Navy field activities.
3. Stock control of aeronautical materials at all aviation supply facilities, including control of packing, preservation, and distribution of material under ASO cognizance to, from, and between aviation supply facilities and major supply points.
4. Maintenance of complete records of material on order and followup procedures necessary to effect timely deliveries for all material under ASO cognizance.
5. Maintenance of up-to-date records of existing storage facilities at depots, major supply points, and operating stations for aeronautical materials, and control of influx of materials in aviation supply channels so as not to exceed existing storage facilities.
6. Determination and disposition of obsolete and excess aeronautical material under NavAirSysCom cognizance.
7. Preparation and distribution of the Navy Stock List of ASO, including interchangeability data.
8. Compilation and distribution of some allowance lists subject to approval by NavAirSysCom.
9. Compilation of lists of spare parts to be salvaged from surveyed aircraft.
10. Followup on delivery, stock recording, reallocating as necessary, and distributing change material promulgated by NavAirSysCom.
11. Establishment and maintenance of a statistical unit which assembles, compiles, and analyzes usage data.
12. Maintenance of a representative at each aircraft manufacturer's plant who keeps ASO fully informed, as requested, as to all changes which affect spare parts under procurement.
13. Establishment of an inspection service which inspects aviation supply activities within established naval districts.

FLEET RESOURCES OFFICE

The Fleet Resources Office (FRO) is established within the Naval Material Command to carry out the Chief of Naval Material assignment as an agent of CNO for administering operating budgets for CINCLANTFLT, CINCPACFLT, CINCUSNAVEUR, CNATRA, and CNRTC (referred to as operating forces commanders). FRO serves as the focal point for formulation, justification, and execution of the budget of those component commands, although decisions as to programing, budgeting, and allocation level are made by CNO.

FRO reviews coordinates and compiles budget material in format for submission to higher authority and administers allocations from CNO to the foregoing major claimants, observing all limitations as to program or budget categories and approved reprograming levels. In the budget formulation process the FRO also coordinates, with the budget submissions of the Navy operating forces commanders, those budgetary requirements of the Commandant of the Marine Corps which are funded from the Operations, Navy account.

OPERATION BUDGETS

Approved operating budgets concerning naval aviation are authorized by NavAirSysCom to the user activity to spend a certain amount of money during a given length of time for specified purposes. User activities are shore commands, which operate aircraft, and the major air type commanders.

Operating funds for stations, rework facilities, etc., concerned with the operation and maintenance of aircraft and related equipment, are allotted to them by the NavAirSysCom as an operating budget. Departments within these organizations normally submit their department budget to the station comptroller who reviews and combines the different department budgets into a recommended station budget. Senior PH's may be called upon to assist in furnishing a realistic estimate of division operating expenses and future needs which the department head may use in formulating the department budget.

Since there is a relatively long period between budget submission and the subsequent receipt of funds, the necessity of accurate estimates of future requirements and strict management of materials for which allocated funds are expended cannot be overemphasized.

Operating funds for squadrons and units are apportioned to them by their type commander as an Operating Target (OPTAR). Routine nonaviation expenses for operating squadrons and units are absorbed by the ship or station to which assigned.

OPERATING TARGETS

Funds to finance the operation of aircraft are allotted by the NavAirSysCom to the air type commanders. Operating funds for the squadrons and units are apportioned to them by their cognizant air type commanders as an operating target (OPTAR). An OPTAR is a planned estimate which the air type commander allocates for the financing of aircraft operating costs during a given period of time. OPTAR's are issued on a quarterly basis and unused funds from the previously issued OPTAR revert to the control of the type commander as each new OPTAR is authorized. Type commanders provide OPTAR's to squadrons, units, and ships under their operational control, whether or not the user activity is based ashore.

There are several different types of OPTAR's issued by the air type commanders for aviation purposes. Two that are of interest to PH personnel are flight operations and aircraft maintenance funds. These are discussed in the following paragraphs.

Flight operations funds are used primarily for the purpose of financing actual flight operations; therefore, they have application at the organization level. These funds finance the following:

1. Aviation fuels and lubricants consumed in aircraft.
2. Liquid oxygen.
3. Aerial film for use in aircraft cameras.
4. Flight clothing and operational equipment authorized in NavAirSysCom Allowance List (NavAir 00-35QH-2).
5. Flight deck safety shoes.
6. Squadron administrative consumable office supplies.
7. Material and services required when located at an activity without Navy or Marine Corps intermediate maintenance capability.

Aircraft maintenance funds are provided to organizational and intermediate maintenance activities to finance the cost of various supplies and materials consumed in the performance of aviation maintenance. These funds finance the following:

1. Repair parts, common hardware, lubricants, cleaning agents, cutting compounds, metals, and other materials incorporated into or expended in the performance of aviation maintenance of aircraft, engines, aeronautical components and subassemblies, and Navy maintenance of aviation maintenance support equipment.
2. Fuels and lubricants consumed by aircraft engines in the performance of complete section repairs.
3. Preexpended, consumable maintenance material.
4. Replacement of expendable or consumable allowance list items with material accountability codes B and C. (Allowance list and material accountability codes are discussed later in this chapter.)

Navy Stock Account (NSA)

The NSA comprises all material purchased with capital from the Naval Stock Fund (NSF) and held in store awaiting issue.

When activities requisition NSA items, the cost of the items is deducted from the activity's applicable quarterly OPTAR, and this amount is credited to NSF. This creates a revolving cycle of purchasing, storing, and issuing of material which keeps the combined assets of NSF and NSA at a constant level.

Stock numbers prefixed by D, N, or W are NSA items.

Appropriation Purchases Account (APA)

APA consists of material which has been procured and paid for out of funds taken from the annual appropriations and held in store awaiting issue. Issues of APA items are NOT chargeable against any local OB or OPTAR.

Stock numbers prefixed by 2R, 8R, or 2V are APA items. Some publications and requisitioning procedures frequently drop the first digit for APA material, thus 2R is referred to as R, etc.

Table 3-1 lists some of the more common cognizance symbols, with the type material controlled and inventory manager. The trend to single manager concept and the refinement of management techniques result in frequent change in these and other management codes. Such changes make it impractical to list all the cognizance symbols.

The cognizance symbol 2R depicted in table 3-1 designates the item of supply as being APA material and under the inventory control of the Aviation Supply Office (ASO).

MATERIAL IDENTIFICATION

In addition to the task of supervising lower rated PH personnel in the performance of routine duties, senior PH's in some cases have duties that will encompass the task of assisting in the procurement of material and parts used by the production personnel. One important area of material procurement is the correct identification of the items required.

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity not positively known. A knowledge of the various methods of identifying material other than by stock number will often help speed the completion of a maintenance task. Certain data may be available which do not identify an item but which may lead to positive identification.

The cataloging system developed by the Department of Defense is such that it identifies with one name and stock number any item of supply that is carried in any or all governmental agencies. In the procurement of material it is normally necessary to identify your material requirement in the medium understandable to the supply system—the federal stock number.

FEDERAL STOCK NUMBERING SYSTEM

The Defense Cataloging Standardization Act provides for a uniform system of identification, classification, and stock numbering throughout the Department of Defense. It places all like items under a federal stock number bearing a common official government name and is applicable to all agencies within the Department of Defense.

Under the federal cataloging system, federal stock numbers are required for all items that are subject to central inventory management within the Department of Defense. Each Navy item to be stocked under centralized inventory control is assigned a federal stock number which is used in all supply management functions. This federal stock number is listed in supply publications in which the item is referenced.

The Federal Stock Numbering System is intended to create and improve standardization of items of military supply in servicewide use and reduce excess inventories.

Federal Stock Number (FSN)

The FSN is an 11-digit number which furnishes positive identification of virtually all items of supply from purchase to final disposition. The 11 digits are uniformly arranged in groups of 4, 3, and 4 digits, with groups separated by hyphens. The 11 digits are made up of a 4-digit federal supply classification class (FSC) and a 7-digit federal item identification number (FIIN). In addition to the 11-digit number, the Navy supply system utilizes certain code prefixes and suffixes to aid in the performance of various management functions. These codes are of significance only within the Navy and are not used during interservice transactions. When the prefixes and suffixes are used, the FSN is known as a coded FSN.

Figure 3-1 describes the format of a coded FSN, including applicable management codes for an item of supply under the cognizance of ASO.

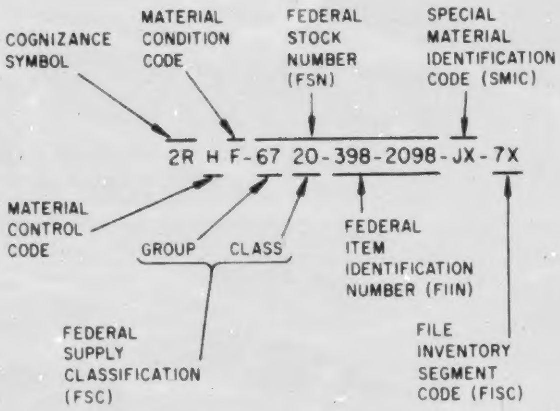
Table 3-1.—Cognizance symbols.

Cognizance symbol	Cognizant inventory manager	Stores account	Technical responsibility	Definition
0I	Naval Publications and Forms Center, Philadelphia	None	Navy Publications and Printing Service	Publications
1I	Naval Publications and Forms Center, Philadelphia	NSA	Navy Publications and Printing Service	Forms
1N	Navy Electronic Supply Office	NSA	Various systems commands	Electronic assemblies and repair parts
1R	Navy Aviation Supply Office	NSA	Naval Air Systems Command	Aeronautical, photographic, and meteorological material (consumable or expense type material)
1W	Navy Fuel Supply Office	NSA	Naval Supply Systems Command	Bulk and drummed liquid petroleum fuels, bulk lubricating oils, bulk dry-cleaning solvents, calibrating fluids and corrosion preventives, new and used drums, and miscellaneous petroleum items
2R	Navy Aviation Supply Office	APA	Naval Air Systems Command	Aeronautical, photographic, and meteorological material (repairable or investment type material)
2V	Naval Air Systems Command	APA	Naval Air Systems Command	Photographic, meteorological, and aeronautical support equipment
8R	Naval Air Systems Command	APA	Naval Air Systems Command	Major aeronautical systems and equipment
9Z	Navy Fleet Material Support Office	NSA	Various bureaus and commands	Navy owned stocks of defense industrial material

The following paragraphs discuss the various parts of a coded FSN, and frequent reference to figure 3-1 will assist in understanding the composition of coded FSN's.

Federal Supply Classification

Federal Supply Class. This number is made up of the federal group code and the federal supply


COGNIZANCE SYMBOL
MATERIAL CONDITION CODE
FEDERAL STOCK NUMBER (FSN)
SPECIAL MATERIAL IDENTIFICATION CODE (SMIC)
2R H F-67 20-398-2098-JX-7X
MATERIAL CONTROL CODE
GROUP
CLASS
FEDERAL ITEM IDENTIFICATION NUMBER (FIIN)
FEDERAL SUPPLY CLASSIFICATION (FSC)
FILE INVENTORY SEGMENT CODE (FISC)

PH.381

Figure 3-1.—Breakdown of a federal stock number.

classification code (FSC). For photographic materials it is usually composed of four digits. It is significant because it relates the item of supply to other items of supply in the same federal supply classification class; for example, most photographic materials are in the 6700 class.

Federal Item Identification Number

Federal Item Identification Number (FIIN). This number is comprised of seven digits and further identifies the item in the federal stock numbering system. FIIN is nonsignificant because it does not determine the position or sequences of the item in relation to other items. It serves to symbolize and fix the identity of the individual item of supply and to differentiate it from others.

Special Material Identification Code (SMIC)

Special Material Identification Code (SMIC). This code is added to each federal stock number used by the Naval Aeronautical Supply Organization. SMIC is used to indicate the management and reporting segment of the inventory to which the stock number is assigned. It provides a means of segmentizing the inventory to keep peculiar parts with the assemblies on which used and thereby providing for efficient procurement, inventory reporting and control, financial reporting, storage, and issue.

The SMIC consists of a two letter code which should always be shown with the federal stock number, as well as the other required codes. These codes are to insure proper handling within the Naval Aeronautical Supply Organization.

File Inventory Segment Code (FISC)

The FISC is a two-character code added to the SMIC. The first character is a number from 1 through 7 which identifies the ASO file or biweekly inventory segment; the second character is always a nonsignificant X. The FISC applies to R and V cognizance symbol material and is added to the FSN for the internal purpose of ASO.

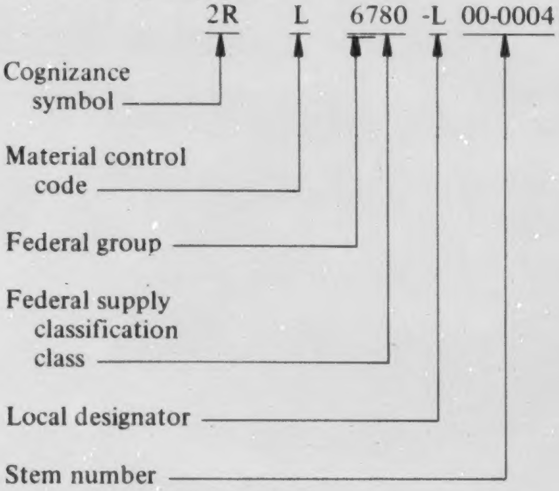
Local Stock Numbers

Certain material categories are exempted from the federal cataloging system. Those materials exempted include the following:

1. Items procured on a one-time basis for immediate used in research and development, experimentation, construction, or maintenance. These items are not subject to centralized item inventory management, reporting, or stock control.
2. Items procured locally and intended solely for local use or consumption, and not subject to centralized management, reporting, or stock control.
3. Items obtained through overseas procurement and intended solely for overseas use.
4. Items procured with nonappropriated funds.
5. Items source coded in a series other than the P series in applicable NavAir publications.

Local stock numbers may be assigned to items exempted from the federal cataloging system. A local stock number is constructed in the same format as a federal stock number with the material code "L" signifying a local stock number.

The stem number is serially assigned starting with 00-0001. Each additional stock number is assigned the next higher number as shown by the following example:



These local stock numbers have no supply system significance; they are used for local management purposes only. A listing of local stock numbers with applicable indentification data is provided to applicable local commands. Stocks carried under these numbers are also reported to the cognizant inventory manager by supply to prevent duplication of manufacture or purchase items and to give the manager an opportunity to identify the item to an existing FSN.

AERONAUTICAL ALLOWANCE LISTS

This title is inclusive of publications identified as Allowance Lists (except advanced base lists), Initial Outfitting Lists, and Tables of Basic Allowances.

Naval Air Systems Command Allowance Lists, Initial Outfitting Lists, and Tables of Basic Allowances are prepared by the NavAirSysCom or the Aviation Supply Office. In nearly all instances, ASO has the responsibility for preparation; but in all cases, these lists are published by the direction of and approved by the NavAirSysCom. These lists contain the following:

1. The equipment and material (both consumable and nonconsumable) necessary to outfit and maintain units of the aeronautical organization in a condition of material readiness.
2. Substantially all items used with sufficient frequency to justify their issuance to all activities maintaining aircraft or equipment for which the lists are designed.
3. Information concerning stock number, nomenclature, interchangeability, and supersedures.
4. A set of detailed instructions for the application and utilization of the publication.
5. A table of logistic data showing the total weight and cube of all material contained in the list.

In the final analysis, the equipment and spare parts listed in these publications are made available to aircraft operating and maintenance activities in accordance with assigned operational maintenance and logistic responsibilities through appropriate application of allowance lists and outfitting actions. The Aviation Supply Office has the responsibility for continually reviewing and updating allowance lists.

INITIAL OUTFITTING LISTS

Initial Outfitting Lists are publications which indicate the range and quantities of maintenance spare parts considered necessary to support various aeronautical end items. These lists contain repair parts, such as airframe parts, electronic parts, engine parts, and general aeronautical equipment. The material covered by Initial Outfitting Lists is normally retained in supply department stocks until required for issue. This allowance of material is provided to ships or activities and is firm only at the time of initial outfitting. Increases and decreases in both range and/or quantities of material are based upon usage data of each activity concerned. Each series list is designed to support an aircraft, electronic equipment, or some other aeronautical article.

ALLOWANCE LISTS

These are publications which indicate the range and quantities of equipment and material considered necessary for maintenance support of assigned and/or supported aircraft. Generally, these items are in-use items required for daily or continual use.

TABLES OF BASIC ALLOWANCE

Publications listing equipment and material required by activities for performance of assigned mission are known as Tables of Basic Allowance. They contain both shop equipment and common supporting spare parts. They cover allowances of tools and equipment required for use by fleet squadrons and pilotless target aircraft activities.

A complete listing of Aeronautical Allowance Lists and Tables of Basic Allowance, with NavAirSysCom publication numbers and their effective dates, is contained in NavSup Publication 2002, Section VIII, Part C.

IDENTIFICATION AND TYPES OF ALLOWANCE LISTS

Allowance Lists and Initial Outfitting Lists are identified by the NavAirSysCom publication number 00-35Q (Series), while Tables of Basic Allowance are identified by the NavAirSysCom publication number 00-35T (Series). The following paragraphs discuss some of the various sections of allowance lists.

These lists are applicable to all photographic laboratories authorized by the Chief of Naval Operations with the exception of class "G" and "Special" laboratories and the Marine Corps ground forces, as set forth in OpNav Instruction 3150.6 (Series).

Allowance and Initial Outfitting lists are excellent sources of information for identifying material. The Allowance Lists include instructions for procuring and disposing of equipment and material. Section "P" allowance lists are identified as follows:

1. Photographic Equipment for Non-Photo Configured Aircraft–NavAir 00-35QP-1.
2. Photographic Material for Aircraft Carriers and Seaplane Tenders–NavAir 00-35QP-2.
3. Photographic Equipment and Materials for non-Aviation Ships and Shipboard Laboratories–NavAir 00-35QP-3.
4. Approved Laboratories Ashore (Navy and Marine Corps) NavAir 00-35QP-6.
5. Aircraft Cameras and Components for Photographic Configured Aircraft–NavAir 00-35QP-7.
6. Photographic Material for Underwater Demolition Unit, Underwater Demolition Team, Beach Jumper Unit, Cargo Handling Battalion, Mobile Construction Battalion, and Guided Missile Group–NavAir 00-35QP-8.
7. Photographic Interpretation Equipment and Material–NavAir 00-35QP-11.

Initial outfitting lists pertinent at present are identified as follows:

1. Maintenance Spare Parts for Support of the Integrated Operations Intelligence Center–NavAir 00-35QP-21.
2. Spare Parts for Support Equipment for the I.O.I.C.–NavAir 00-35QP-22.
3. RA-5C Photographic Systems–NavAir 00-35-QP-30.
4. RA-3B Photographic System–NavAir 00-35QP-32.
5. F-4A/F-4B Photographic System–NavAir 00-3QP-33.
6. RF-4B Photographic System–NavAir 00-35QP-34.

DEVIATIONS FROM ALLOWANCE LIST REQUIREMENTS

It is the policy of the NavAirSysCom to make available to each Navy activity the authorized equipment and repair parts necessary to insure operational readiness. Allowance list requirements are not mandatory and deviations are approved as pointed out in the following paragraphs.

Type, Force, and major operating commanders, or their subordinate logistics commanders, may authorize deviations from allowance list requirements including one-time in-excess issue of equipment for a requirement not considered generally applicable to other activities of the same type, or for independent operations of detached activities.

Organizational and Intermediate maintenance activities often have requirements for equipment which does not appear on existing allowance lists. In some cases the equipment is requested because it is considered superior to existing equipment or it may be the result of an entirely new requirement; that is, for rework of a component to perform repairs or services for which no previous capability existed.

In order to assure that each request for deviation is properly reviewed and evaluated for validity and possible application to other maintenance activities, the originating activity should submit an official request to the Naval Air Systems Command Headquarters, via the chain of command (including the cognizant NavAirSysComRep). The following general procedures are followed in approval or rejection for a new piece of support equipment where no previous capability or need existed.

The request, toghether with complete justification, should be forwarded via the chain of command to the NavAirSysComHq. The request should not be made through supply system channels. The type commander normally identifies, on the forwarding endorsement, the Intermediate maintenance activity which will perform the equipment evaluation if different from the requesting activity.

FORMS, PUBLICATIONS, AND CATALOGS

Forms, publications, and catalogs are valuable "tools" to the PH in both supply and laboratory administration. They must be available to the PH who needs the information they contain on a day to day basis.

The PH must be familiar with the general contents of these publications so that he will know where to look for the information he needs to do his job. Some of the more common publications pertaining to aviation supply and the types of supply catalogs that a PH uses to identify material and parts are discussed in this section.

NavAir Photographic Technical Bulletin NavAir 10-1TB-62 contains a table of instructions and publications for photographic personnel. (See table 3-2.)

NAVY STOCK LIST OF FORMS AND PUBLICATIONS

The Navy Stock List of Forms and Publications, NavSup Publication 2002, Section VIII, Part C, contains a complete numerical listing of all available naval aeronautic publications distributed by NavAir and stocked for issue.

Coded numbers assigned to publications issued by NavAir divide this material into its proper categories. The manuals and publications pertaining to Photography are in the 10 series, for the most part. However, there are some manuals that are listed under other series numbers; for example, the maintenance instructions manuals for reconnaissance aircraft and equipment are listed under the 01 series. A brief explanation of the coding of publications is given in the introduction of NavSup Publication 2002. A table of contents and general alphabetical cross-reference listing are also provided in the stock lists.

These stock lists are revised periodically by the issuance of supplements. The stock lists and supplements should be used together. The supplement contains a listing of the publications canceled or distributed since the date of the stock lists.

NAVY STOCK LIST

The parts of the Navy Stock List (ASO) that are used by the Photographer's Mate are Section WEL0067–Weapons Equipment List of Supporting Repair Parts for Photographic Equipment; WEL0068–Weapons Equipment List for Photographic Equipment and Supplies; and WEL0069–Weapons Equipment List for Specialized Photographic Material.

The purpose of sections WEL0067, WEL0068, and WEL0069 of the Navy Stock List is to describe the equipment and materials contained therein and for identification of those materials. The primary equipments are listed alphabetically by name. Each primary equipment is followed first by its components, and second, when applicable, by related equipments and their components. Within name, arrangement is alphanumerical by type designation, or by physical characteristics if no type designation exists.

NAVAL AIR SYSTEMS COMMAND PUBLICATIONS

Publications dealing primarily with the operation and maintenance of aircraft and related equipment within the Department of the Navy are issued by or under the direction of the Naval Air Systems Command.

NavAir publications are identified by a three part code preceded by NA for NavAir (some

Table 3-2.–Instructions/Publications for Photographic Personnel.

ITEM	INSTRUCTION/PUBLICATION	PURPOSE	SOURCE
1.	OPNAV INSTRUCTION 3150.6 Series MANUAL OF NAVAL PHOTOGRAPHY	Provides guidance for all phases of Naval photography.	Submit letter request to: Supply and Fiscal Department Code 514.32 Naval Station Washington, D.C. 20390
2.	OPNAV INSTRUCTION 3150.2 Series AUTHORIZED PHOTOGRAPHIC LABORATORIES (ASHORE)	Provides current list of authorized laboratories ashore within and outside the continental United States.	Same as Item 1 above
3.	NAVAIR INSTRUCTION 10700.2 Series ACCOUNTABILITY AND DISPOSITION OF PHOTOGRAPHIC INTERPRETATION EQUIPMENT, GUIDELINES AND INSTRUCTIONS CONCERNING	Provides guidance for the submission of Photographic Inventory Report; Repair/overhaul of inoperative photographic equipment and method for obtaining replacements; Disposition instructions for material in excess requirements.	Same as Item 1 above
4.	ASO PUBLICATION: WEL 0067 EQUIPMENT LIST OF SUPPORTING REPAIR PARTS FOR PHOTOGRAPHIC MATERIAL Publication FSN: 0533-400-0067	Lists part numbers/FSN of bits and pieces required to support repairable cameras/photographic equipment at field level.	Submit Milstrip Requisition through normal supply channels; see Note below.
5.	ASO PUBLICATION: E 0068 LIST OF PHOTOGRAPHIC EQUIPMENT AND SUPPLIES Publication FSN: 0053-400-0068	Lists all "R" Cognizant standard stock photographic equipment and film, paper and chemicals identified for Navy use.	Submit Milstrip Requisition through normal supply channels; see Note below.

Table 3-2.–Instructions/Publications for Photographic Personnel–Continued.

6.	ASO PUBLICATION: WEL 0069 EQUIPMENT LIST FOR SPECIALIZED PHOTOGRAPHIC MATERIAL Publication FSN: 0053-400-0069	Lists all 2V Cognizance standard stock photographic material under the issue control of Naval Air Systems Command. Also includes standard stock photographic material recently transferred from 2V Cognizance to 2R Cognizance under the distribution control of ASO.	Submit Milstrip Requisition through normal supply channels; see Note below.
7.	DOD CONSOLIDATED FEDERAL SUPPLY CATALOG C6750-IL IDENTIFICATION LIST, FSC CLASS 6750 PHOTOGRAPHIC SUPPLIES. Publication FSN: 0557-610-0100 Change Bulletin FSN: 0557-610-0101	Listing of all consumable photographic supplies procured for all DOD activities, by the Defense General Supply Center. This listing can be used to supplement the listing provided in the Navy catalog, E 0068 (Item 5 listed above). Requisitioning procedures are the same in accordance with Item 5 above in order to obtain material.	Automatic distribution by NavalPublications and Forms Center (NPFC) Philadelphia, Pa. 19111 to all activities with authorized photographic laboratories. In the event the photographic laboratory does not receive the copy, recommend check with the Supply Department and the Administration Department. In the event that neither office has the publication, submit a letter request for distribution to NPFC CODE 105.
	Obtain the following QP allowance list (Items 8a. through 8h.) peculiar to your activity for retention in the photographic spaces.		
8a.	NAVAIR 00-35QP-1 Series PHOTOGRAPHIC EQUIPMENT FOR NON-PHOTO CONFIGURED AIRCRAFT Publication FSN: 0800-011-4050, I COG	Lists allowance quantities of photographic equipment/consumable photographic material for aircraft squadrons other than photo squadrons.	Submit Milstrip Requisition through normal supply channels; see Note below.
8b.	NAVAIR 00-35QP-2 Series PHOTOGRAPHIC EQUIPMENT AND MATERIAL FOR AIRCRAFT CARRIERS AND AVIATION SHIPS Publication FSN: 0800-011-5000	Lists allowance quantities of photographic equipment/consumable photographic material for aircraft carriers and other aviation type ships.	Submit Milstrip Requisition through normal supply channels; see Note below.
8c.	NAVAIR 00-35QP-3 Series PHOTOGRAPHIC EQUIPMENT FOR NON-AVIATION SHIPS AND SHIPBOARD LABORATORIES Publication FSN: 0800-011-5500	Lists allowance quantities of photographic equipment/consumable photographic material for ships and shipboard photographic laboratories other than aircraft carriers and aviation type ships.	Submit Milstrip Requisition through normal supply channels; see Note below.

Table 3-2.–Instructions/Publications for Photographic Personnel–Continued.

8d.	NAVAIR 00-35QP-6 PHOTOGRAPHIC EQUIPMENT FOR AUTHORIZED NAVY AND MARINE CORPS LABORATORIES ASHORE Publication FSN: 0800-011-6500	Lists allowance quantities of photographic equipment/consumable photographic material for shore based photographic laboratories.	Submit Milstrip Requisition through normal supply channels; see Note below.
8e.	NAVAIR 00-35QP-7 AIRCRAFT CAMERAS AND COMPONENTS FOR PHOTOGRAPHIC CONFIGURED AIRCRAFT Publication FSN: 0800-011-7050	Lists allowance quantities of cameras and associated components for photographic squadrons.	Submit Milstrip Requisition through normal supply channels; see Note below.
8f.	NAVAIR 00-35QP-8 PHOTOGRAPHIC EQUIPMENT AND MATERIAL FOR SHORE BASED UNITS OF THE FLEET OPERATING FORCES Publication FSN: 0800-032-7000, I COG	Lists allowance quantities of photographic equipment/consumable photographic material for miscellaneous operational fleet activites ashore without a supporting shore based photo laboratory.	Submit Milstrip Requisition through normal supply channels; see Note below.
8g.	NAVAIR 00-35QP-11 Series IMAGE INTERPRETATION EQUIPMENT AND MATERIAL Publication FSN: 0800-011-4501, I COG	Lists allowance quantities of photographic interpretation equipment and consumable supplies for intelligence/interpretation activites.	Submit Milstrip Requisition through normal supply channels; see Note below.
8h.	NAVAIR 00-35QP-21 Series MAINTENANCE SPARE PARTS FOR SUPPORT OF THE PHOTOGRAPHIC COMPONENTS OF THE INTEGRATED OPERATIONS INTELLIGENCE CENTER (IOIC) Publication FSN: 0800-030-5500, I COG	Lists initial outfitting requirements for support of the IOIC photographic equipment. Peculiar to ships/stations having an IOIC photographic laboratory.	Submit Milstrip Requisition through normal supply channels; see Note below.
9.	EQUIPMENT TECHNICAL MANUALS/ TECHNICAL BULLETINS	Required to support equipment and obtain information concerning equipment or processes/techniques.	These publications are listed in the "Navy Stock List of Forms and Publications, Cognizance Symbol I" NAVSUP Publication 2002, Section VIII, Part C (see item 10 below).

The following publications are of use to the Supply and Administration personnel within the Photographic Section. Retention of the following publications in the photographic spaces would be the prerogative of the Photo Officer. They usually consist of many volumes and take up a great deal of space. Usage would be dependent on the type of activity, and availability of personnel to make revisions. These publications are normally updated every 1 to 3 months.

Table 3-2.–Instructions/Publications for Photographic Personnel–Continued.

10.	NAVSUP 2002 Series NAVY STOCK LIST OF FORMS AND PUBLICATIONS, COGNIZANCE SYMBOL I, SECTION VIII, PART C	Contains complete listing of all available Naval/Aeronautical Technical Manual/Technical Bulletins by Publication Number, FSN, Title, and information on how to order the publications.	Normally available for perusal at Administrative Office / Technical Libraries or Supply Department. If required submit Milstrip requisition through normal supply channels; see Note below.
11.	ASO PUBLICATION SECTION C0004 MASTER REPAIR LIST OF NAVY AVIATION MATERIALS Publication FSN: 0533-001-3020	Publication is in three parts. Part 1 contains a listing of all standard stock aviation repairable assemblies by FSN/Nomenclature/Unit of Issue/Unit Price/Designated Overhaul Point/MFRS Federal Supply Code/Part Number. Part 2 references Part number to FSN and contains special instructions for sending material to commercial overhaul or in accordance with Interservice Depot Maintenance Agreements. Part 3 gives specifications on the packaging of material to be shipped to overhaul.	Normally available for perusal at local Supply Department. Contains 5 volumes (or more) and updated on a monthly basis. If required submit Milstrip requisition through normal supply channels; see Note below. † Material shall not be turned into Supply when in need of repair/overhaul until requirements of NAVAIR INSRUCT 10700.2 have been fulfilled (Item 3 above).
12.	DEFENSE LOGISTICS SERVICES CENTER PUBLICATION NAVY MASTER CROSS REFERENCE LIST (MCRL) Publication No.: C-RL-1-N	Cross reference of all Navy managed items by part number to FSN.	Normally available for perusal at local supply department; it contains approximately 20 volumes.
13.	DEFENSE LOGISTICS SERVICES CENTER PUBLICATION NAVY MASTER CROSS REFERENCE LIST (MCRL) Publication No.: C-RL-2-N	Cross reference of all Navy managed items by FSN to part number.	Normally available for perusal at local supply department; it contains approximately 20 volumes.

Note: Milstrip requisition (DD Form 1348) shall be forwarded to Naval Forms and Publication Center, 5801 Tabor Avenue, Philadelphia, Pa. 19111 for issue. Enter the publication identification number, and title in the REMARKS section of the DD 1348 to assure delivery of the correct publication.

EXAMPLE: NAVAIR 00-35QP-1, PHOTOGRAPHIC EQUIPMENT FOR NON-PHOTOGRAPHIC CONFIGURED AIRCRAFT

* These instructions/publications should be retained in the photographic spaces for ready reference.

older but still current publications are preceded by NW for NavWeps). The three parts which make up the code are utilized to indicate the following:

1. PART I consists of numbers to identify the general subject category with the basic subject to which they pertain (See table 3-3).

2. PART II consists of numbers or numbers and letters which identify either the manufacturer and specific aircraft and engine or the title assigned the sub-headings in specific subject heading category (table 3-4).

3. PART III consists of one, two, or three numbers. When used with the basic subject categories 01, 02, 09, or 28, this part of the code designates a specific kind of publication within that category, such as operations (-1), maintenance (-2), structural repair (-3), illustrated parts breakdown (-4), etc. For other basic categories this part is assigned in numerical sequence as means of identification and has no particular significance.

Table 3-3.—General subject classification numbers for manual type publications.

General	00
Aircraft	01
Powerplants (02A Reciprocating engines, 02B Jet engines, 02F Rocket engines)	02
Accessories	03
Hardware and Rubber Material	04
Instruments	05
Fuels, Lubricants, and Gases	06
Dopes and Paints	07
Electronics	08 & 16
Instructional Equipment and Training Aids	09 & 28
Photography	10
Aviation Armament	11
Fuel and Oil Handling Equipment	12
Parachute and Personal Survival Equipment	13
Hangars and Flying Field Equipment	14
Standard Preservation and Packaging Instructions	15
Machinery, Tool, and Test Equipment	17 & 18
Ground Servicing and Automotive Equipment	19
Descriptive Data Sheets for Aviation Support Equipment	20
Chemical Equipment	24 & 39
Meteorology	50
Ship Installations	51

Table 3-4.—General manuals—00 series.

00-15	Inspection Manuals
00-25	Miscellaneous
00-35O	Aviation Fire Control Allowance Lists
00-35Q	Allowance Lists and Initial Outfitting Lists
00-35T	Tables of Basic Allowances
00-55	Gadget Digest
00-75	Air Safety
00-80	Aviation Training
00-85	Protective Packaging and Preservation Packaging
00-100	Evaluation Program of Aviation Shore Facilities
00-105	Aircraft Fire Protection
00-110	Standard Aircraft Characteristics
00-120	Air Launched Guided Missiles
00-500	Naval Aeronautical Publications Indexes

The NavAir publications discussed in the following paragraphs are of primary concern to the PH.

NAVAL AERONAUTIC PUBLICATIONS INDEX

The Naval Aeronautic Publications Index is composed of three cross reference type publications which are used in conjunction with Section VIII, Parts C and D, of NavSup Publication 2002 to form a comprehensive catalog of NavAir publications and technical directives. NavSup Pub 2002 (Navy Stock List of Publications and Forms) is discussed later in this chapter under NavSup pubs. The three publications are NavAir 00-500A (Equipment and Subject Applicability

List), NavAir 00-500B (Aircraft Application List), and NavAir 00-500C (Directive Application List by Aircraft Configuration). They are discussed in the following paragraphs.

NavAir 00-500A

This publication lists aircraft components and related equipment first by class of equipment, and then by type or part number in alphanumeric sequence, with applicable publications shown in their appropriate columns. It is necessary to know the class of the equipment, model, and type or part number in order to find the publication coverage in this index. Since the part numbers are arranged in alphanumeric sequence, it is a simple matter to find the number in question and then the applicable publication coverage.

NavAir 00-500B

This index lists NavAir technical manuals with respect to their applicability to an aircraft. Since this index is issued primarily as a ready reference, the various model designations assigned to aircraft configuration series have been combined under one heading. For example, the A-3B, EA-3B, RA-3B, TA-3B, and VA-3B are grouped together. Thus, publications listed under these series may be applicable to possibly one or all of the models.

NavAir 00-500C

This publication lists active NavAir Technical directives with respect to their applicability to an aircraft. It is arranged first by aircraft series, second by aircraft configuration, and third by airframe/aircraft bulletin and/or change numbers. This index is used as a ready reference for determining aircraft application for current NavAir technical directives. This publication is used in conjunction with the NSL of Publications and Forms, Section VIII, Part D.

NAVY MANAGEMENT DATA LIST

The Navy Management Data List (NMDL) consists of two separate sections. One section, the Fleet Ballistics Missile Weapons System Supplement, has application only to submarine forces.

The other section, titled the Management Data List, includes basic management data necessary for preparing material requisitions. Also, it is the instrument for publishing data relative to stock number changes, unit of issue, unit price, shelf life of material, number of items contained in a package, and associated information.

The NMDL is designed to disseminate management type information as it relates to the FSN. It is not designed to be a comprehensive catalog of material in the supply system or to identify an item to an FSN; therefore, it cannot be used as a shopping guide. It is printed in federal item identification number sequence. In order to get the necessary FSN or other information needed to make effective use of the NMDL, additional publications must be used in conjunction with the NMDL. These include the Deleted and Superseded FIIN List, the Consolidated Repairable Item List, and the Federal Supply Catalog Navy Master Cross Reference List.

NAVAL MATERIAL CATALOGS

Federal and naval material catalogs provide the information necessary to identify and procure items of material for the operation and maintenance of activities ashore and afloat. How and which catalogs to use will become apparent in this section and the following section on identification source data.

Illustrated Parts Breakdown (IPB)

The IPB and allowance lists continue to be the most important source for obtaining information necessary to order specific support equipment parts. Properly used, they will provide reference information necessary to identify a part number to the specific model of equipment and in some cases provide interchangeability data that can be utilized when the prime item requested is not in stock. Parts interchangeability is discussed in greater detail later in this chapter.

An Illustrated Parts Breakdown, also known as Illustrated Maintenance Parts List or Illustrated Parts Catalog, is prepared by the manufacturer for each model of aircraft, most items of ground support equipment, engines, accessories, or other aeronautical equipment considered advisable by NavAirSysCom and is printed and issued by the authority of NavAirSysCom. The IPB is designed to enable supply and maintenance personnel to identify and order replacement parts for aircraft or equipment. All procurable assemblies and detail parts are illustrated and listed in such a manner as to make possible quick identification of assemblies and their component parts. The items are arranged continuously in assembly breakdown order with the illustrations placed as near as possible to their appropriate listing.

Although slight variations in format exist among the various IPB's, each usually includes the following major sections.

The INTRODUCTION includes general information about the equipment, contents of the publication, and instructions for its use. The introduction should be referred to prior to using an unfamiliar IPB.

The GROUP ASSEMBLY PARTS LIST consists of a breakdown of the complete unit into major components, systems, installations, assemblies, and detail parts. Generally, parts are indexed in disassembly order. In some instances, assemblies or installations are shown in assembled form on one figure and the detail parts are illustrated on another figure. In these cases, the parenthetical note "(See figure___ for breakdown)" appearing after the description refers to the figure number of the illustration on which the detail parts of the subassembly can be found. The parenthetical note "(See figure___ for next higher assembly)," indicates the figure where the item can be found in assembled form.

The NUMERICAL INDEX lists part numbers in alphanumerical order, and each part number is cross referenced to the figure and index number where it is illustrated. This section also shows the total quantity of each part used in the equipment, material source code, and federal stock number when applicable.

The REFERENCE DESIGNATION INDEX has been added to later editions of IPB's. This index lists in alphanumerical order reference designators (Example: B1, J1, K7, etc.) for symbols on schematic and wiring diagrams. The index also lists part numbers and index numbers of where the parts are located in the IPB.

When using the IPB, consider if a failed part is one that was installed as a result of a technical directive, the part number may not appear in the IPB. The index manual for IPB volumes will include a list of directives which have been incorporated into the IPB's. For information on parts where the directive has not been incorporated, the directive may provide the necessary information for ordering a replacement item.

Descriptive/Identification Lists and Illustrated Shipboard Shopping Guides

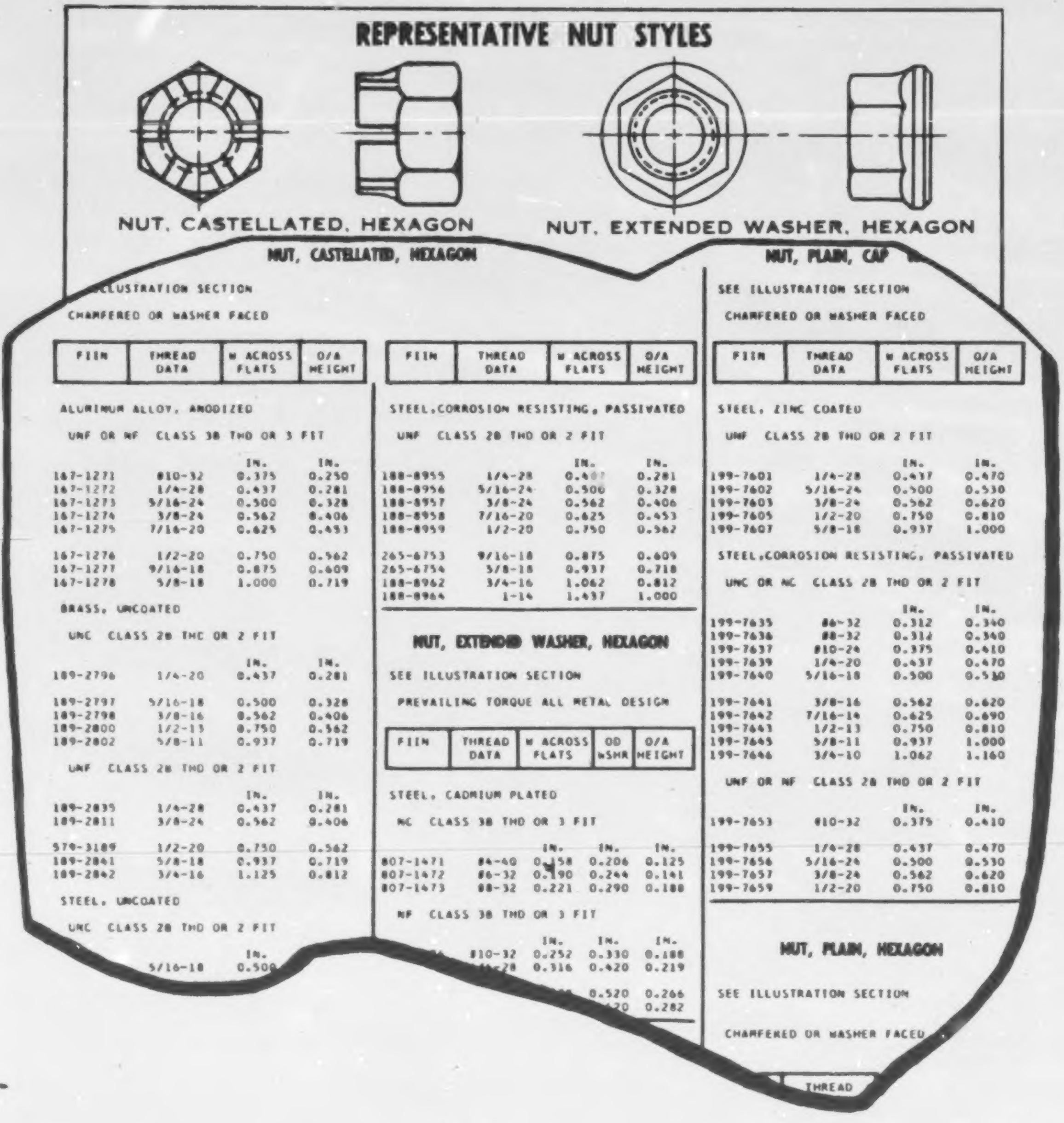
Descriptive type catalogs or Identification Lists (IL's) are available on all FSC group materials. These lists catalog material by what it is rather than by what it is used on. These catalogs are similar to the Sears Roebuck/Montgomery Ward type catalogs, which have a comprehensive alphabetical index, group like items together, and thoroughly describe the items (size, weight, composition, etc.)

The Illustrated Shipboard Shopping Guides (ISSG) are similar in many ways to the IL's. They are designed to assist fleet personnel in identifying those items of supply not normally related to a part number or reference number to an FSN. They also provide assistance in determining substitute items by virtue of illustrations, specifications, and narrative descriptions from which data can be compared.

Figure 3-2 illustrates a page from the Illustrated Shipboard Shopping Guide, Section 5310.

Navy Deleted and Superseded FIIN List (DSFL)

The Navy Deleted and Superseded FIIN List is the historical record of stock number deletions and supersessions. The DSFL is printed in old FIIN sequence and lists old FIIN's which have been canceled and cross references old FIIN's to superseding FIIN's. In the event that an old FIIN was superseded more than once, it will cross reference to the latest FIIN. The change notice code indicates the reason for cancellation or supersession of the old FIIN.



REPRESENTATIVE NUT STYLES

NUT. CASTELLATED. HEXAGON

NUT. EXTENDED WASHER. HEXAGON

NUT, CASTELLATED, HEXAGON

ILLUSTRATION SECTION

CHAMFERED OR WASHER FACED

FIIN	THREAD DATA	W ACROSS FLATS	O/A HEIGHT
ALUMINUM ALLOY, ANODIZED			
UNF OR NF CLASS 3B THD OR 3 FIT			
		IN.	IN.
167-1271	#10-32	0.375	0.250
167-1272	1/4-28	0.437	0.281
167-1273	5/16-24	0.500	0.328
167-1274	3/8-24	0.562	0.406
167-1275	7/16-20	0.625	0.453
167-1276	1/2-20	0.750	0.562
167-1277	9/16-18	0.875	0.609
167-1278	5/8-18	1.000	0.719
BRASS, UNCOATED			
UNC CLASS 2B THC OR 2 FIT			
		IN.	IN.
189-2796	1/4-20	0.437	0.281
189-2797	5/16-18	0.500	0.328
189-2798	3/8-16	0.562	0.406
189-2800	1/2-13	0.750	0.562
189-2802	5/8-11	0.937	0.719
UNF CLASS 2B THD OR 2 FIT			
		IN.	IN.
189-2835	1/4-28	0.437	0.281
189-2811	3/8-24	0.562	0.406
579-3189	1/2-20	0.750	0.562
189-2841	5/8-18	0.937	0.719
189-2842	3/4-16	1.125	0.812
STEEL, UNCOATED			
UNC CLASS 2B THD OR 2 FIT			
		IN.	
	5/16-18	0.500	

FIIN	THREAD DATA	W ACROSS FLATS	O/A HEIGHT
STEEL, CORROSION RESISTING, PASSIVATED			
UNF CLASS 2B THD OR 2 FIT			
		IN.	IN.
188-8955	1/4-28	0.437	0.281
188-8956	5/16-24	0.500	0.328
188-8957	3/8-24	0.562	0.406
188-8958	7/16-20	0.625	0.453
188-8959	1/2-20	0.750	0.562
265-6753	9/16-18	0.875	0.609
265-6754	5/8-18	0.937	0.718
188-8962	3/4-16	1.062	0.812
188-8964	1-14	1.437	1.000

NUT, EXTENDED WASHER, HEXAGON

SEE ILLUSTRATION SECTION

PREVAILING TORQUE ALL METAL DESIGN

FIIN	THREAD DATA	W ACROSS FLATS	OD WSHR	O/A HEIGHT
STEEL, CADMIUM PLATED				
NC CLASS 3B THD OR 3 FIT				
		IN.	IN.	IN.
807-1471	#4-40	0.158	0.206	0.125
807-1472	#6-32	0.190	0.244	0.141
807-1473	#8-32	0.221	0.290	0.188
NF CLASS 3B THD OR 3 FIT				
		IN.	IN.	IN.
	#10-32	0.252	0.330	0.188
	-28	0.316	0.420	0.219
			0.520	0.266
			20	0.282

NUT, PLAIN, CAP

SEE ILLUSTRATION SECTION

CHAMFERED OR WASHER FACED

FIIN	THREAD DATA	W ACROSS FLATS	O/A HEIGHT
STEEL, ZINC COATED			
UNF CLASS 2B THD OR 2 FIT			
		IN.	IN.
199-7601	1/4-28	0.437	0.470
199-7602	5/16-24	0.500	0.530
199-7603	3/8-24	0.562	0.620
199-7605	1/2-20	0.750	0.810
199-7607	5/8-18	0.937	1.000
STEEL, CORROSION RESISTING, PASSIVATED			
UNC OR NC CLASS 2B THD OR 2 FIT			
		IN.	IN.
199-7635	#6-32	0.312	0.340
199-7636	#8-32	0.312	0.340
199-7637	#10-24	0.375	0.410
199-7639	1/4-20	0.437	0.470
199-7640	5/16-18	0.500	0.530
199-7641	3/8-16	0.562	0.620
199-7642	7/16-14	0.625	0.690
199-7643	1/2-13	0.750	0.810
199-7645	5/8-11	0.937	1.000
199-7646	3/4-10	1.062	1.160
UNF OR NF CLASS 2B THD OR 2 FIT			
		IN.	IN.
199-7653	#10-32	0.375	0.410
199-7655	1/4-28	0.437	0.470
199-7656	5/16-24	0.500	0.530
199-7657	3/8-24	0.562	0.620
199-7659	1/2-20	0.750	0.810

NUT, PLAIN, HEXAGON

SEE ILLUSTRATION SECTION

CHAMFERED OR WASHER FACED

THREAD

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Figure 3-2.—ISSG, Section 5310.

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NOTE: The DSFL does not constitute automatic authority to substitute or effect interchangeability. The change notice code should be considered and the items end use application must be known to determine if the superseding FIIN is a valid replacement item.

The ISSG is a multivolume publication consisting of an introduction and master index plus a number of individual sections applicable to material in the specific federal supply classes or groups.

The master index provides an alphabetical sequence listing of all item names included in the ISSG, with reference to the individual sections (FSC group or class) wherein they appear. The index is similar to that shown in figure 3-3.

Cross Reference Lists

The term "cross reference list" is a general term normally relating to cross referencing between reference numbers/manufacturer's part numbers, and federal stock numbers. Most catalogs published by the Navy or the Defense Supply Agency have a cross reference section listing part numbers and stock numbers of items contained therein.

A master cross reference list (MCRL) is the term applied to a publication which accumulates and consolidates the information from all the separate cross reference lists. The Defense Logistics Services Center (Defense Supply Agency) publishes an MCRL for the Navy which is distributed by the Fleet Material Support Office (FMSO). Also, ASO publishes an MCRL entitled "ASO Cross Reference for Naval Aviation Interest Items-Part Number to Federal Stock Number." (ASO section C0006). The FMSO MCRL is a more comprehensive publication (approximately 24 volumes plus a multivolume supplement) and contains information of interest to all elements of the Navy. ASO's MCRL, along with C0006A (variation code supplement), is tailored to aviation requirements. It would be the preferred MCRL for aviation supply support activities. Other specialized MCRL's published by ASO include:

1. Section C0017, Master Cross Reference of Parts Kits—identifies repairable assemblies to their repair parts kits.

2. Section C0018, Model Cross Reference List—identifies ASO's model codes, which appear in various ASO catalogs, to the FSN's of the repairable assemblies to which they apply.

3. Section C0020, TSMC/WSMC to SMIC conversion guide of Navy aviation materials—for converting FSN with old Technical Supply Management Codes (TSMC) and Weapons System Management Codes (WSMC) to the new FSN with a Special Material Identification Code (SMIC).

Figure 3-4 illustrates a page from the MCRL published by the Defense Logistics Services Center. The data is arranged in reference number sequence, with its applicable Manufacturer's Code (FSCM), Reference Number Variation Code, and FSN shown in adjacent columns.

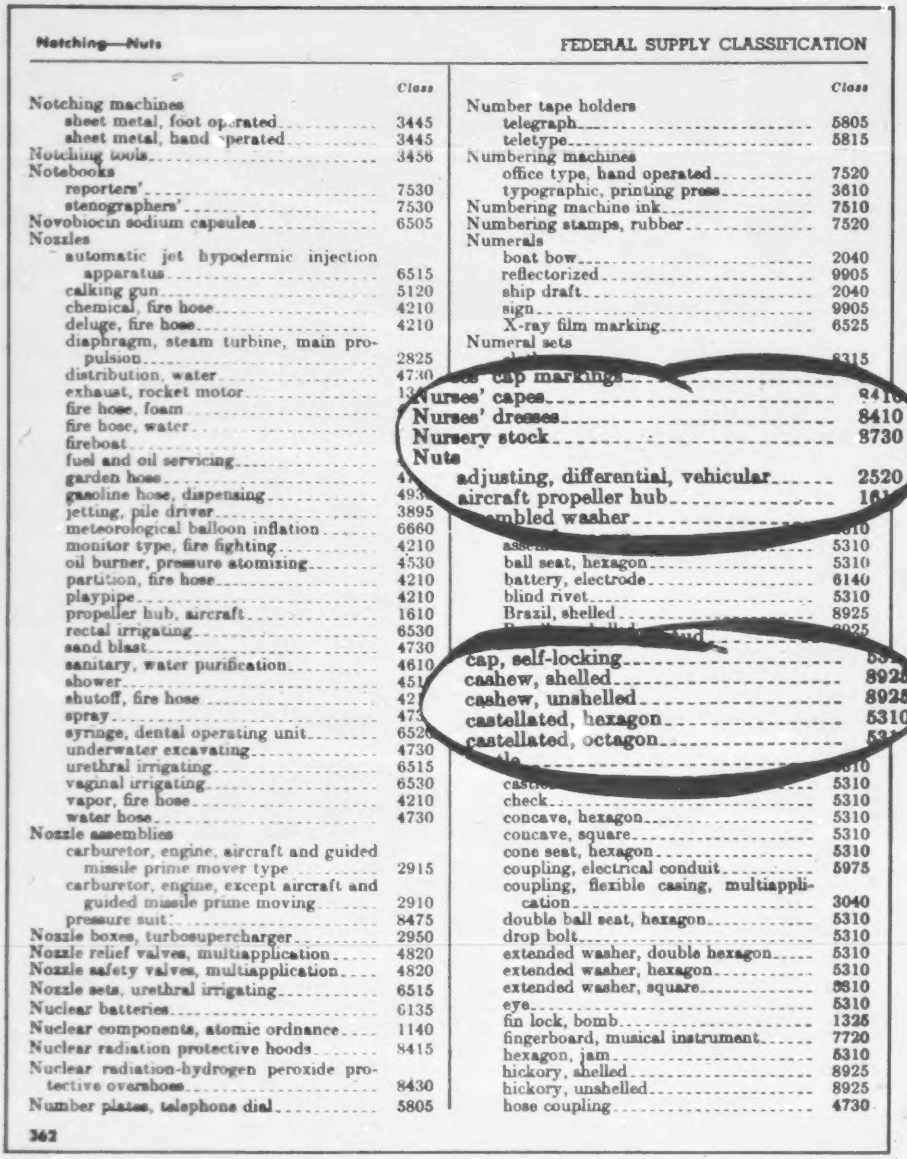
It is recommended in looking up a reference number that the various methods of representing the number be recognized. If the number cannot be found in the form represented in the IPB or found on the part itself, try various arrangements of the part number before assuming its exclusion. For example:

13 7BCAL 23B
13-7BCAL-23B
13-7BCAL23B
137BCAL-23B
137BCAL23B

Once the FSN is located, it will be necessary to cross reference the FSN in the management data list, the list of repairable assemblies, or one of the other previously mentioned catalogs to verify that the part number has been cross referenced to the correct part by checking the nomenclature in addition to the manufacturer's code provided by the MCRL.

The federal supply code for the manufacturer can be crossed to the manufacturer's name by using the Federal Supply Code for Manufacturers (Code to Name) Cataloging Handbook H4-2.

When identical reference numbers are identified to the same FSCM but to two or more different stock numbers, the reference number variation code 2 will indicate that additional data is required to correctly identify the item of supply. In cases of this sort, the Variation Data Supplement List for the MCRL should be checked to aid in correct identification. Figure 3-5 is a portion of the page from a supplement



Notching—Nuts

FEDERAL SUPPLY CLASSIFICATION

	Class
Notching machines	
sheet metal, foot operated	3445
sheet metal, hand operated	3445
Notching tools	3456
Notebooks	
reporters'	7530
stenographers'	7530
Novobiocin sodium capsules	6505
Nozzles	
automatic jet hypodermic injection apparatus	6515
calking gun	5120
chemical, fire hose	4210
deluge, fire hose	4210
diaphragm, steam turbine, main propulsion	2825
distribution, water	4730
exhaust, rocket motor	13
fire hose, foam	
fire hose, water	
fireboat	
fuel and oil servicing	
garden hose	47
gasoline hose, dispensing	493
jetting, pile driver	3895
meteorological balloon inflation	6660
monitor type, fire fighting	4210
oil burner, pressure atomizing	4530
partition, fire hose	4210
playpipe	4210
propeller hub, aircraft	1610
rectal irrigating	6530
sand blast	4730
sanitary, water purification	4610
shower	451
shutoff, fire hose	421
spray	473
syringe, dental operating unit	6520
underwater excavating	4730
urethral irrigating	6515
vaginal irrigating	6530
vapor, fire hose	4210
water hose	4730
Nozzle assemblies	
carburetor, engine, aircraft and guided missile prime mover type	2915
carburetor, engine, except aircraft and guided missile prime moving	2910
pressure suit	8475
Nozzle boxes, turbosupercharger	2950
Nozzle relief valves, multiapplication	4820
Nozzle safety valves, multiapplication	4820
Nozzle sets, urethral irrigating	6515
Nuclear batteries	6135
Nuclear components, atomic ordnance	1140
Nuclear radiation protective hoods	8415
Nuclear radiation-hydrogen peroxide protective overshoes	8430
Number plates, telephone dial	5805

	Class
Number tape holders	
telegraph	5805
teletype	5815
Numbering machines	
office type, hand operated	7520
typographic, printing press	3610
Numbering machine ink	7510
Numbering stamps, rubber	7520
Numerals	
boat bow	2040
reflectorized	9905
ship draft	2040
sign	9905
X-ray film marking	6525
Numeral sets	
[illegible]	8315
cap markings	
Nurses' capes	841
Nurses' dresses	8410
Nursery stock	8730
Nuts	
adjusting, differential, vehicular	2520
aircraft propeller hub	161
mbled washer	10
assem	5310
ball seat, hexagon	5310
battery, electrode	6140
blind rivet	5310
Brazil, shelled	8925
[illegible]	925
stud	
cap, self-locking	53
cashew, shelled	892
cashew, unshelled	8925
castellated, hexagon	5310
castellated, octagon	53
[illegible]	10
cast	5310
check	5310
concave, hexagon	5310
concave, square	5310
cone seat, hexagon	5310
coupling, electrical conduit	5975
coupling, flexible casing, multiapplication	3040
double ball seat, hexagon	5310
drop bolt	5310
extended washer, double hexagon	5310
extended washer, hexagon	5310
extended washer, square	5310
eye	5310
fin lock, bomb	1325
fingerboard, musical instrument	7720
hexagon, jam	5310
hickory, shelled	8925
hickory, unshelled	8925
hose coupling	4730

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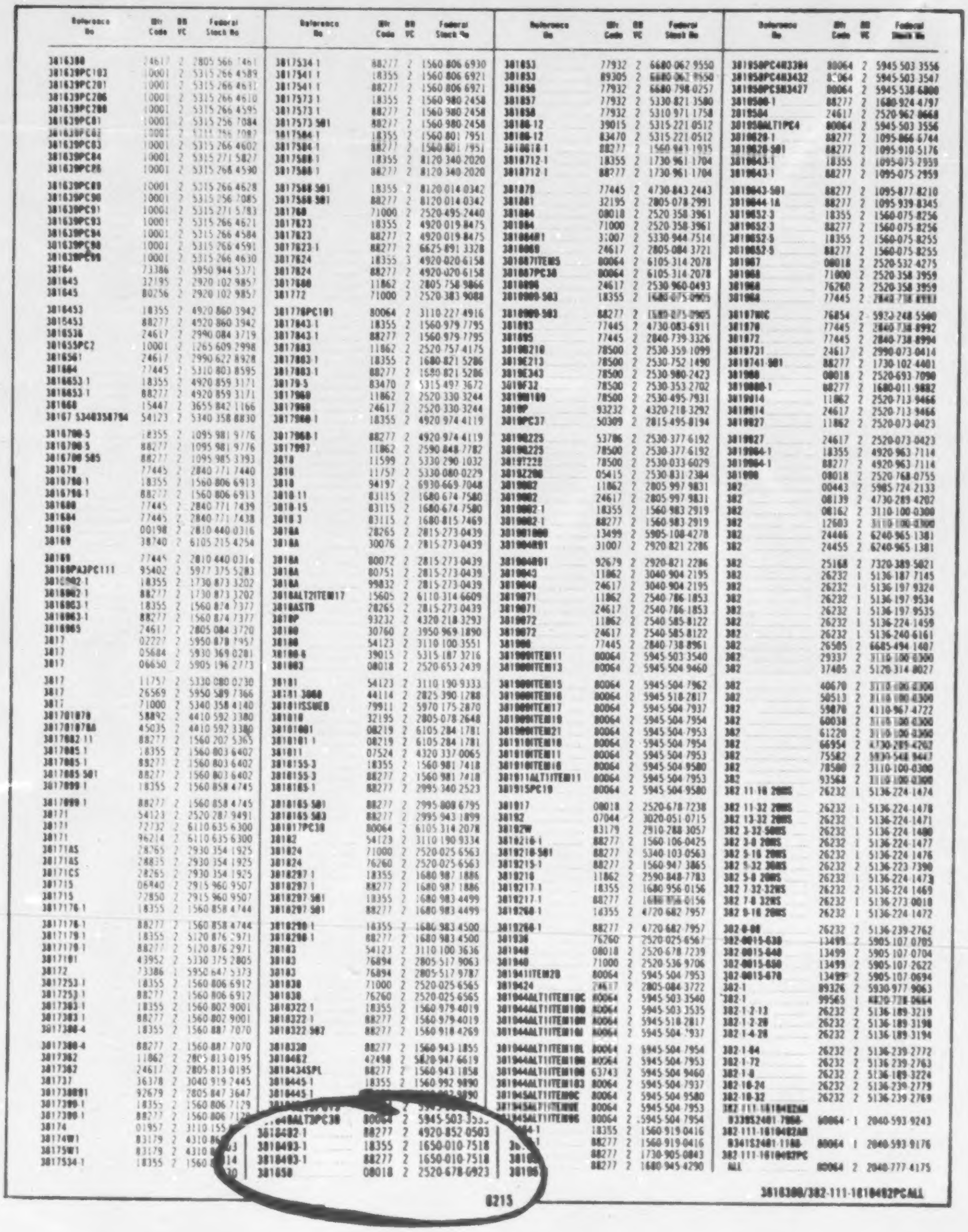
AK.78

Figure 3-3.—Cataloging Handbook H2-3—description to federal supply classification (FSC).



Reference No	Mfr Code	RR VC	Federal Stock No
3816300	24617	2	2805 566 7461
381639PC103	10001	2	5315 266 4589
381639PC201	10001	2	5315 266 4631
381639PC206	10001	2	5315 266 4610
381639PC208	10001	2	5315 266 4595
381639PC81	10001	2	5315 256 7084
381639PC82	10001	2	5315 256 7087
381639PC83	10001	2	5315 266 4602
381639PC84	10001	2	5315 271 5827
381639PC86	10001	2	5315 268 4590
381639PC88	10001	2	5315 266 4628
381639PC90	10001	2	5315 256 7085
381639PC91	10001	2	5315 271 5783
381639PC93	10001	2	5315 266 4621
381639PC94	10001	2	5315 266 4584
381639PC98	10001	2	5315 266 4591
381639PC99	10001	2	5315 266 4630
38164	73386	2	5950 944 5371
381645	32195	2	2920 102 9857
381645	80256	2	2920 102 9857
3816453	18355	2	4920 860 3942
3816453	88277	2	4920 860 3942
3816536	24617	2	2990 084 3719
381655PC2	10001	2	1265 609 2998
3816561	24617	2	2990 622 8928
381664	77445	2	5310 803 8595
3816653 1	18355	2	4920 859 3171
3816653 1	88277	2	4920 859 3171
381668	15447	2	3655 842 1166
38167 5340358794	54123	2	5340 358 8830
3816700-5	18355	2	1095 981 9776
3816700-5	88277	2	1095 981 9776
3816700 505	88277	2	1095 985 3393
381679	77445	2	2840 771 7440
3816790 1	18355	2	1560 806 6913
3816790 1	88277	2	1560 806 6913
381680	77445	2	2840 771 7439
381684	77445	2	2840 771 7438
38169	00198	2	2810 440 0316
38169	38740	2	6105 215 4254
38169	77445	2	2810 440 0316
38169PA3PC111	95402	2	5977 375 5283
3816902 1	18355	2	1730 873 3202
3816902 1	88277	2	1730 873 3202
3816903 1	18355	2	1560 874 7377
3816903 1	88277	2	1560 874 7377
3816905	24617	2	2805 084 3720
3817	02227	2	5950 878 7957
3817	05684	2	5930 369 0281
3817	06650	2	5905 196 2773
3817	11757	2	5330 080 0230
3817	26569	2	5950 589 7366
3817	71000	2	5340 358 4140
381701070	58892	2	4410 592 3380
381701070A	45035	2	4410 592 3380
3817082 11	88277	2	1560 202 5365
3817085 1	18355	2	1560 803 6402
3817085 1	89277	2	1560 803 6402
3817085 501	88277	2	1560 803 6402
3817090 1	18355	2	1560 858 4745
3817090 1	88277	2	1560 858 4745
38171	54123	2	2520 287 9491
38171	72732	2	6110 635 6300
38171	96214	2	6110 635 6300
38171AS	28265	2	2930 354 1925
38171AS	28835	2	2930 354 1925
38171CS	28265	2	2930 354 1925
381715	06940	2	2915 960 9507
381715	72850	2	2915 960 9507
3817176 1	18355	2	1560 858 4744
3817176 1	88277	2	1560 858 4744
3817179 1	18355	2	5120 876 2971
3817179 1	88277	2	5120 876 2971
3817181	43952	2	5330 375 2805
38172	73386	1	5950 647 5373
3817253 1	18355	2	1560 806 6912
3817253 1	88277	2	1560 806 6912
3817303 1	18355	2	1560 802 9001
3817303 1	88277	2	1560 802 9001
3817300-4	18355	2	1560 887 7070
3817300-4	88277	2	1560 887 7070
3817362	11862	2	2805 813 0195
3817362	24617	2	2805 813 0195
381737	36378	2	3040 919 2445
381738081	92679	2	2805 847 3647
3817390 1	18355	2	1560 806 7129
3817390 1	88277	2	1560 806 7129
38174	01957	2	3110 155 [illegible]
38174W1	83179	2	4310 86[illegible]3
38175W1	83179	2	4310 [illegible]14
3817534 1	18355	2	1560 [illegible]30
3817534-1	88277	2	1560-806-6930
3817541-1	18355	2	1560-806-6921
3817541-1	88277	2	1560-806-6921
3817573-1	18355	2	1560-980-2458
3817573-1	88277	2	1560-980-2458
3817573-501	88277	2	1560-980-2458
3817584-1	18355	2	1560-801-7951
3817584-1	88277	2	1560-801-7951
3817588-1	18355	2	8120-340-2020
3817588-1	88277	2	8120-340-2020
3817588-501	18355	2	8120-014-0342
3817588-501	88277	2	8120-014-0342
381760	71000	2	2520-495-2440
3817623	18355	2	4920-019-8475
3817623	88277	2	4920-019-8475
3817623-1	88277	2	6625-891-3328
3817624	18355	3	4920-020-6158
3817624	88277	2	4920-020-6158
3817680	11862	2	2805-758-9866
381772	71000	2	2520-383-9088
381778PC101	80064	2	3110-227-4916
3817843-1	18355	2	1560-979-7795
3817843-1	88277	2	1560-979-7795
3817883	11862	2	2520-757-4175
3817883-1	18355	2	1680-821-5286
3817883-1	88277	2	1680-821-5286
38179-5	83470	2	5315-497-3672
3817960	11862	2	2520-330-3244
3817960	24617	2	2520-330-3244
3817960-1	18355	2	4920-974-4119
3817968-1	88277	2	4920-974-4119
3817987	11862	2	2590-848-7782
3818	11599	2	5330-290-1032
3818	11757	2	5330-080-0229
3818	94197	2	6930-669-7048
3818-11	83115	2	1680-674-7580
3818-15	83115	2	1680-674-7580
3818-3	83115	2	1680-815-7469
3818A	28265	2	2815-273-0439
3818A	30076	2	2815-273-0439
3818A	80072	2	2815-273-0439
3818A	80751	2	2815-273-0439
3818A	99832	2	2815-273-0439
3818ALT2ITEM17	15605	2	6110-314-6609
3818ASTD	28265	2	2815-273-0439
3818P	93232	2	4320-218-3293
38180	30760	2	3950-969-1890
38180	54123	2	3110-100-3551
38180-6	39015	2	5315-187-3216
381803	00018	2	2520-653-2439
38181	54123	2	3110-190-9333
38181 3060	44114	2	2825-390-1288
38181ISSUED	79911	2	5970-175-2870
381810	32195	2	2805-078-2648
38181001	08219	2	6105-284-1781
3818101 1	08219	2	6105-284-1781
381811	07524	2	4320-337-0065
3818155-3	18355	2	1560-981-7418
3818155-3	88277	2	1560-981-7418
3818165-1	88277	2	2995-340-2523
3818165-501	88277	2	2995-800-6795
3818165-503	88277	2	2995-943-1899
381817PC38	80064	2	6105-314-2078
38182	54123	2	3110-190-9334
381824	71000	2	2520-025-6563
381824	76260	2	2520-025-6563
3818297-1	18355	2	1680-987-1886
3818297-1	88277	2	1680-987-1886
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3818297-501	88277	2	1680-983-4499
3818298-1	18355	2	1680-983-4500
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38183	54123	2	3110-100-3636
38183	76894	2	2805-517-9063
38183	76894	2	2805-517-9787
381830	71000	2	2520-025-6565
381830	76260	2	2520-025-6565
3818322-1	18355	2	1560-979-4019
3818322-1	88277	2	1560-979-4019
3818322-502	88277	2	1560-918-4269
3818330	88277	2	1560-943-1855
3818462	42498	2	5820-947-6619
3818434SPL	88277	2	1560-943-1858
3818445-1	18355	2	1560-992-9890
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3818493-1	18355	2	1650-010-7518
3818493-1	88277	2	1650-010-7518
381850	00018	2	2520-678-6923
381853	77932	2	6680-062-9550
381853	89305	2	6680-062-9550
381856	77932	2	6680-798-0257
381857	77932	2	5330-821-3580
381858	77932	2	5310-971-1758
38186-12	39015	2	5315-221-0512
38186-12	83470	2	5315-221-0512
3818618-1	88277	2	1560-943-1935
3818712-1	18355	2	1730-961-1704
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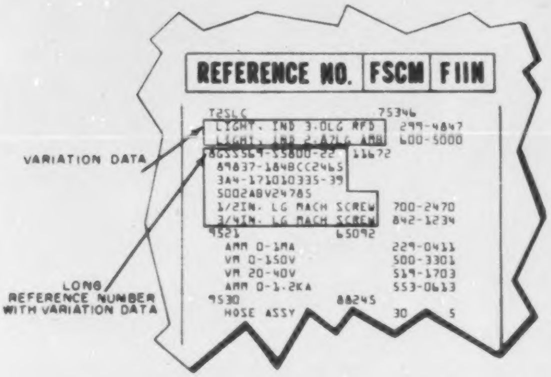
381878	77445	2	4730-843-2443
381881	32195	2	2805-078-2991
381884	00018	2	2520-358-3961
381884	71000	2	2520-358-3961
38188481	31007	2	5330-944-7514
3818869	24617	2	2805-084-3721
381887ITEM5	80064	2	6105-314-2078
381887PC38	80064	2	6105-314-2078
3818896	24617	2	2530-960-0493
3818900-503	18355	2	1680-075-0905
3818900-503	88277	2	1680-075-0905
381893	77445	2	4730-083-6911
381895	77445	2	2840-739-3326
3819E210	78500	2	2530-359-1099
3819E213	78500	2	2530-752-1490
3819E343	78500	2	2530-980-2423
3819F32	78500	2	2530-353-2702
3819M100	78500	2	2530-495-7931
3819P	93232	2	4320-218-3292
3819PC37	50309	2	2815-495-8194
38190225	53706	2	2530-377-6192
38190225	78500	2	2530-377-6192
3819T228	78500	2	2530-033-6029
3819Z208	05415	2	2530-831-2384
3819002	11862	2	2805-997-9831
3819002	24617	2	2805-997-9831
3819002-1	18355	2	1560-983-2919
3819002-1	88277	2	1560-983-2919
38190100	13499	2	5905-108-4278
381904801	31007	2	2920-821-2286
381904801	92679	2	2920-821-2286
3819043	11862	2	3040-904-2195
3819048	24617	2	3040-904-2195
3819071	11862	2	2540-786-1853
3819071	24617	2	2540-786-1853
3819072	11862	2	2540-585-8122
3819072	24617	2	2540-585-8122
381908	77445	2	2840-738-8961
381900ITEM11	80064	2	5945-503-3540
381900ITEM13	80064	2	5945-504-9460
381900ITEM15	80064	2	5945-504-7962
381900ITEM16	80064	2	5945-518-2817
381900ITEM17	80064	2	5945-504-7937
381900ITEM18	80064	2	5945-504-7954
381900ITEM21	80064	2	5945-504-7953
381910ITEM10	80064	2	5945-504-7954
381910ITEM11	80064	2	5945-504-7953
381910ITEM16	80064	2	5945-504-9580
381911ALT1ITEM11	80064	2	5945-504-7953
381915PC10	80064	2	5945-504-9580
381917	00018	2	2520-678-7238
38192	07044	2	3020-051-0715
38192W	83179	2	2910-288-3057
3819216-1	88277	2	1560-106-0425
3819210-501	88277	2	5340-103-0563
3819215-1	88277	2	1560-947-3865
3819216	11862	2	2590-848-7783
3819217-1	18355	2	1680-956-0156
3819217-1	88277	2	1680-956-0156
3819260-1	14355	2	4720-682-7957
3819260-1	88277	2	4720-682-7957
381938	76260	2	2520-025-6567
381940	00018	2	2520-678-7239
381940	71000	2	2520-536-9706
381941ITEM20	80064	2	5945-504-7953
3819424	24617	2	2805-084-3722
381944ALT1ITEM10C	80064	2	5945-503-3540
381944ALT1ITEM10D	80064	2	5945-503-3535
381944ALT1ITEM10H	80064	2	5945-518-2817
381944ALT1ITEM10I	80064	2	5945-504-7937
381944ALT1ITEM10L	80064	2	5945-504-7954
381944ALT1ITEM10M	80064	2	5945-504-7953
381944ALT1ITEM10N	63743	2	5945-504-9460
381944ALT1ITEM103	80064	2	5945-504-7937
381945ALT1ITEM6C	80064	2	5945-504-9580
381945ALT1ITEM6E	80064	2	5945-504-7953
381945ALT1ITEM6G	80064	2	5945-504-7954
[illegible]-1	18355	2	1560-919-0416
[illegible]-1	88277	2	1560-919-0416
381[illegible]	88277	2	1730-905-0843
381[illegible]	88277	2	1680-945-4290
381950PC4R3384	80064	2	5945-503-3556
381950PC4R3432	80064	2	5945-503-3547
381950PC5R3427	80064	2	5945-538-6800
3819500-1	88277	2	1680-924-4797
3819504	24617	2	2520-962-8668
381950ALT1PC4	80064	2	5945-503-3556
3819620-1	88277	2	1095-866-6744
3819620-501	88277	2	1095-910-5176
3819643-1	18355	2	1095-075-2959
3819643-1	88277	2	1095-075-2959
3819643-501	88277	2	1095-877-8210
3819644-1A	88277	2	1095-939-8345
3819652-3	18355	2	1560-075-8256
3819652-3	88277	2	1560-075-8256
3819652-5	18355	2	1560-075-8255
3819652-5	88277	2	1560-075-8255
381967	00018	2	2520-532-4275
381968	71000	2	2520-358-3959
381968	76260	2	2520-358-3959
381968	77445	2	2840-738-[illegible]
381970NC	76854	2	5930-248-5500
381970	77445	2	2840-738-8992
381972	77445	2	2840-738-8994
3819731	24617	2	2990-073-0414
3819741-501	88277	2	1730-102-4401
381980	00018	2	2520-693-7090
3819800-1	88277	2	1680-011-9882
3819814	11862	2	2520-713-9466
3819814	24617	2	2520-713-9466
3819827	11862	2	2520-073-0423
3819827	24617	2	2520-073-0423
3819864-1	18355	2	4920-963-7114
3819864-1	88277	2	4920-963-7114
381990	00018	2	2520-768-0755
382	00443	2	5985-724-2133
382	08139	2	4730-289-4202
382	08162	2	3110-100-0300
382	12603	2	3110-100-0300
382	24446	2	6240-965-1381
382	24455	2	6240-965-1381
382	25168	2	7320-389-5021
382	26232	1	5136-187-7145
382	26232	1	5136-197-9324
382	26232	1	5136-197-9534
382	26232	1	5136-197-9535
382	26232	1	5136-224-1459
382	26232	1	5136-240-6161
382	26505	2	6685-494-1407
382	29337	2	3110-100-0300
382	37405	2	5120-314-8027
382	40670	2	3110-100-0300
382	50513	2	3110-100-0300
382	59870	2	4110-967-4722
382	60038	2	3110-100-0300
382	61220	2	3110-100-0300
382	66954	2	4730-289-4202
382	75582	2	5930-548-9447
382	78500	2	3110-100-0300
382	93568	2	3110-100-0300
382 11-16 20NS	26232	1	5136-224-1474
382 11-32 20NS	26232	1	5136-224-1478
382 13-32 20NS	26232	1	5136-224-1471
382 3-32 50NS	26232	1	5136-224-1480
382 3-8 20NS	26232	1	5136-224-1477
382 5-16 20NS	26232	1	5136-224-1476
382 5-32 30NS	26232	2	5136-223-7390
382 5-8 20NS	26232	1	5136-224-1473
382 7-32 32NS	26232	2	5136-224-1469
382 7-8 32NS	26232	1	5136-273-0018
382 9-16 20NS	26232	1	5136-224-1472
382-8-80	26232	2	5136-239-2762
382-0015-630	13499	2	5905-107-0705
382-0015-640	13499	2	5905-107-0704
382-0015-650	13499	2	5905-107-2622
382-0015-670	13499	2	5905-107-0694
382-1	89326	2	5930-977-9063
382-1	99565	1	4820-728-0664
382-1-2-13	26232	2	5136-189-3219
382-1-2-20	26232	2	5136-189-3198
382-1-4-20	26232	2	5136-189-3194
382-1-64	26232	2	5136-239-2772
382-1-72	26232	2	5136-239-2763
382-1-8	26232	2	5136-189-3224
382-10-24	26232	2	5136-239-2779
382-10-32	26232	2	5136-239-2769
382-111-1810482AA 0339S2481-7060	60064	1	2040-593-9243
382-111-1810482AB 0341S2481-1160	80064	1	2040-593-9176
382-111-1810482PC ALL	80064	2	2040-777-4175

0215

3816300/382-111-1810482PCALL

AK.71

Figure 3-4.—Federal Supply Catalog MCRL.


VARIATION DATA
LONG REFERENCE NUMBER WITH VARIATION DATA

```
REFERENCE NO.          FSCM   FIIN
T2SLC                  75346
  LIGHT, IND 3.0LG RFD        299-4847
  LIGHT, IND 2.A7LG AMB       600-5000
8GSSS69-SS800-22       11672
  89837-1848CC2465
  3A4-171010335-39
  5002A8V24785
  1/2IN. LG MACH SCREW        700-2470
  3/4IN. LG MACH SCREW        842-1234
9521                   65092
   AMM 0-1MA                  229-0411
   VM 0-150V                  500-3301
   VM 20-40V                  519-1703
   AMM 0-1.2KA                553-0613
9530                   88245
   HOSE ASSY                  30    5
```

AM.903

Figure 3-5.—Navy Cross Reference List-Supplementary Data.

showing amplifying information necessary to identify items with the same reference number and FSCM but several FSN's.

IDENTIFICATION DATA

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity not positively known. A knowledge of some of the various methods of identifying an item to a stock number, a stock number to an item, or the part to a usable number other than a stock number may prove to be very helpful in speeding the completion of a maintenance task.

Manufacturer's Part Number

Normally, the manufacturers of parts stamp, etch, paint, or otherwise affix a part number on each item manufactured. The use of this manufacturer's part number and the knowledge of the parts application (that is, on what equipment is it used) normally lead to the positive identification of the part's nomenclature and federal stock number. The part number can be ascertained to be correct by reference to the appropriate IPB, and the federal stock number may be obtained by reference to the appropriate Master Cross Reference Listing (MCRL). It should be remembered that part numbers may be duplicated by the various manufacturers; therefore, the federal supply code for manufacturers must be considered when cross referencing a part number to the federal stock number.

Drawing Number

A drawing number consists of letters, numbers, or a combination of letters and numbers which are assigned to a particular drawing for identification purposes. The activity controlling the drawing (normally the manufacturer) assigns the number in conformance with their drawing numbering system. One drawing may apply to several items; thus, other distinguishing data may be necessary to identify the item on the drawing.

Drawing numbers may be used to identify the microfilm available on some support equipment and kept in many technical libraries. Some large assemblies are illustrated in IPB's but are not broken down sufficiently to show identifying data for their component parts. By obtaining the drawing number of the larger item and cross referencing it to the applicable microfilm, sufficient identifying information for the component part may be obtained.

Specification Number

Specification numbers are assigned to documents describing the characteristics and the properties of material purchased by the Federal Government. These specifications are used by purchasing officers to insure that all the requirements for the material are met. Specification numbers are particularly useful on some support equipment in trying to procure component parts.

Nameplate

Some support equipment components have nameplates attached which provide such information as manufacturer's name or code, make or model number, serial number, size, voltage, phase, etc. This is particularly helpful when requesting material not subject to the federal cataloging system.

Marking and Measurements

Special coded markings, other than part numbers, and measurements often aid in the idenification of some materials. The senior PH should be familiar with some of the marking and measurements used to identify or separate materials. For instance, compressed gas cylinders are color coded in accordance with Military Standards and serve to identify the contents of the cylinders. Sheet metal is stamped with a significant identifying symbol. Flexible rubber hose is marked with a code symbol and the military specification number. Bare wire is separated according to diameter size. Hose and tubing fittings are sized by measuring (female fittings are measured across the inside diameter of the threaded opening, male fittings are measured across the outside diameter of the male threads).

When Description Is Known

When only the description is known, a different approach is used to arrive at the FSN. There is a variety of publications used for this purpose. They are referred to as descriptive or identification type catalogs and include the following:

1. NavAir Initial Outfitting List, Section A.
2. NavAir Allowance List Sections C, G, H, L, M, O, P, and T.
3. FMSO's Illustrated Shipboard Shopping Guide (ISSG).
4. Federal Supply Catalog Identification Lists.
5. General Service Administration Identification Lists.

These publications vary in format, but have one thing in common; that is, the items contained are arranged according to what they are rather than on what type of equipment they are used. Being arranged by description means also that the items are arranged by FSC structure (discussed earlier in this chapter). Of course, each of these descriptive catalogs has its own alphabetical index. In addition, cataloging Handbook H2-3 is a comprehensive index of all descriptive characteristics arranged alphabetically and showing FSC group and class. (See fig. 3-3.)

If the descriptive name for the items cannot be found in the Cataloging Handbook, it is probably an obsolete or slang name. Try locating another name by referring to an unabridged dictionary or other source.

After identifying the FSC of the item in question, the FSN may be found by referring to the appropriate section of one of the descriptive type catalogs–usually the ISSG or the FSC Identification List. Figure 3-3 illustrates a page from section 5310 of the ISSG.

The Allowance Lists and Initial Outfitting Lists mentioned are covered in the next section of this chapter. They are descriptive in nature and contain only commonly used items. Stock numbers are ascertained by first looking up the item in the alphabetical index and then turning to the page and/or item number indicated.

When Equipment Application Is Known

When the equipment application is known, the publication peculiar to the particular equipment is generally the best source from which to commence identification.

The applicable IPB is a logical source. If the part number is also known, the procedure is greatly simplified. By referring to the IPB numerical index, the illustration and descriptive data can be located. If the person requesting the material is not sufficiently familiar with the item being requested to identify it by proper nomenclature, the assistance of appropriate maintenance personnel should be requested.

SEL's are uniquely designed for use when the part number and equipment application are known. Some items listed in the equipment IPB and SEL are complete units of equipment containing components, subassemblies, and parts which are not listed in the IPB/SEL. In most cases there is an IPB published for these units, either as an individual publication or as part of the maintenance manual or overhaul manual for the unit. Lists of these publications are contained in the applicable IPB and SEL. NavSup Publication 2002, Section VIII, Parts C and D, together with Nav Air 00-500A (Equipment Applicability List)and NavAir 00-500B (Aircraft Application List) may be used to locate virtually every aeronautic publication including Allowance Lists/Outfitting Lists.

When Part Number Is Known

When the part number is known, the federal stock number may be ascertained by reference to one of the serveral "part number to stock number" cross reference listings. These include the federal supply catalog MCRL, ASO catalog section C0006, which is ASO's equivalent to the MCRL, and Support Equipment Reference Lists (SEL) for each major item of support equipment.

For example, part number C1979, FSCM 46529, may be identified as FSN 2RH4920-251-3529-SX by crossing it over in the MCRL and then by referring to the management data list. FSCM 46529 translates to Perfex Corporation of Milwaukee, Wisconsin, in the Cataloging Handbook H4-2.

The part number could have been crossed over in the C0006 ASO catalog section and then referred to ASO's List of Supporting Repair Parts, Section P2310.

Likewise, the part number could have been obtained from the support equipment's IPB and crossed over to a federal stock number in the SEL (fig. 3-6) for the particular make and model of equipment.

As indicated in the coverage on source codes, many items listed in IPB's are source coded other than "P" and will not cross over to an FSN. These are included in the SEL as can be seen in figure 3-6.

Material Unidentifiable to an FSN

Every effort should be made to identify material requirements to an FSN. Frequently, however, this is not possible. Material not subjected to the federal cataloging system cannot be identified to an FSN. Occasionally, material source coded in the P series cannot be identified locally. Requirements for materials not identified to an FSN must be identified in terms familiar to supply and the prospective supplier within the supply system.

The following information should provide sufficient identification:

1. Name of the manufacturer of the item or the five-digit federal manufacturer's code.
2. Part number.
3. Nomenclature.
4. Description of specific application including model of equipment, engine, accessory, or other end assembly on which used.
5. Source code and publication reference if available.
6. FSN or part number of the next higher assembly.

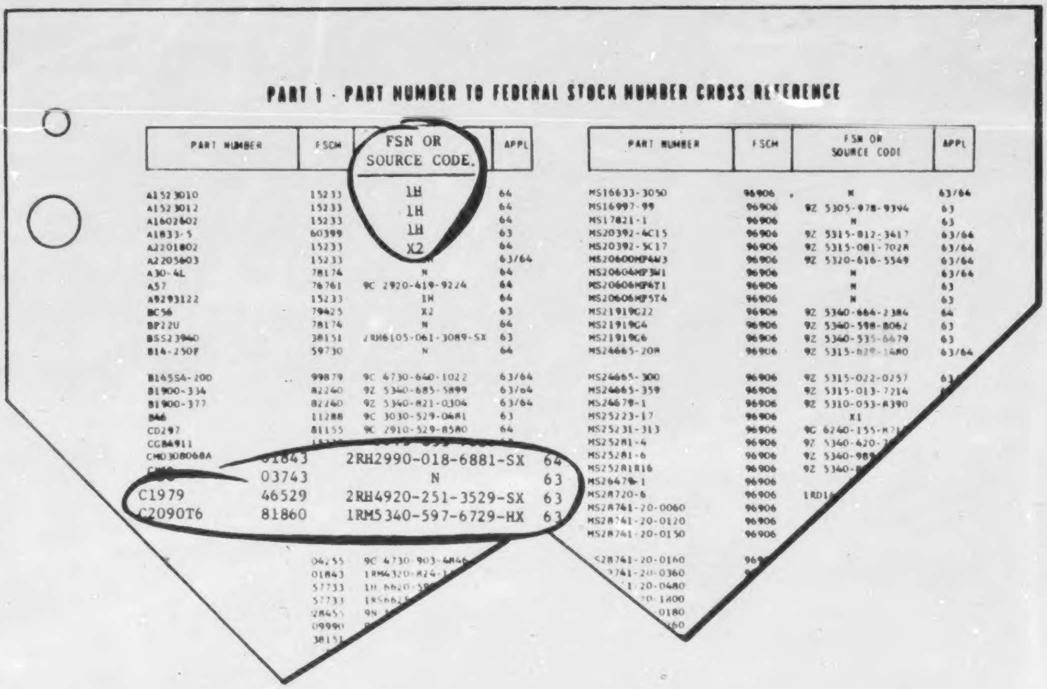
The preceding information was presented to explain data that should assist you in identifying support equipment materials. There are many ways to use this information to obtain the same objective. The important point is to be able to select the significant information which will lead to positive identification of the material needed.

MATERIAL REQUISITIONING

The Navy, through its central procurement system, has already purchased most of the material needed by all activities. The senior Photographer's Mate is chiefly concerned with informing the local supply activity of the type and quantity of materials needed by his particular activity, and/or the appropriate allowance lists. The Photographer's Mate usually accomplishes this function through the use of requisitions, which in the simplest form are merely requests for material made out on the appropriate Navy form and drawn at a naval supply activity. Depending on circumstances, this procedure generally accounts for approximately 95 percent of all procurements. There may be instances in which material is required by open purchase to fill specialized needs. These functions will also be handled by local supply.

MILSTRIP

The Military Standard Requisitioning and Issue Procedure (MILSTRIP), which was developed by the Department of Defense, utilizes standardized procedures, forms, formats, codes, and documentation necessary to effect one basic requisitioning and issue system for all the military departments.



PART 1 - PART NUMBER TO FEDERAL STOCK NUMBER CROSS REFERENCE

PART NUMBER	FSCM	FSN OR SOURCE CODE.	APPL
A1523010	15233	1H	64
A1523012	15233	1H	64
A1602602	15233	1H	64
A1833-5	60399	X2	63
A2201802	15233	[illegible]	64
A2205603	15233	[illegible]	63/64
A30-4L	78174	N	64
A57	76761	9C 2920-419-9224	64
A9293122	15233	1H	64
BC56	79425	X2	63
BP22U	78174	N	64
BSS23960	38151	2RH6105-061-3089-SX	63
B14-250F	59730	N	64
B14554-200	99879	9C 4730-640-1022	63/64
B1900-334	82240	9Z 5340-685-5899	63/64
B1900-377	82240	9Z 5340-821-0304	63/64
B46	11288	9C 3030-529-0681	63
CD297	81155	9C 2910-529-8580	64
CGB4911	[illegible]	[illegible]	[illegible]
CMD308068A	01843	2RH2990-018-6881-SX	64
[illegible]	03743	N	63
C1979	46529	2RH4920-251-3529-SX	63
C2090T6	81860	1RM5340-597-6729-HX	63
	04255	9C 4730-903-4846	
	01843	1RM4320-824-	
	57733	1H 6620-5	
	57733	1RS662	
	28455	9N	
	09990		
	38151		

PART NUMBER	FSCM	FSN OR SOURCE CODE	APPL
MS16633-3050	96906	N	63/64
MS16997-99	96906	9Z 5305-978-9394	63
MS17821-1	96906	N	63
MS20392-4C15	96906	9Z 5315-812-3417	63/64
MS20392-5C17	96906	9Z 5315-081-7028	63/64
MS20600MP4W3	96906	9Z 5320-616-5549	63/64
MS20604MP3W1	96906	N	63/64
MS20606MP6T1	96906	N	63
MS20606MP5T4	96906	N	63
MS21919G22	96906	9Z 5340-664-2384	64
MS21919G4	96906	9Z 5340-598-8062	63
MS21919G6	96906	9Z 5340-535-6679	63
MS24665-208	96906	9Z 5315-829-1480	63/64
MS24665-300	96906	9Z 5315-022-0257	63
MS24665-359	96906	9Z 5315-013-7214	
MS24679-1	96906	9Z 5310-033-8390	
MS25223-17	96906	X1	
MS25231-313	96906	9C 6240-155-87	
MS25281-4	96906	9Z 5340-420-	
MS25281-6	96906	9Z 5340-98	
MS25281R16	96906	9Z 5340-	
MS26479-1	96906		
MS28720-6	96906	1RD1	
MS28741-20-0060	96906		
MS28741-20-0120	96906		
MS28741-20-0150	96906		
S28741-20-0160	969		
741-20-0360			
1-20-0480			
20-1400			
0180			
60			

AS.654

Figure 3-6.—A support equipment reference list (SEL).

As the name implies, the system is designed to effect the requisitioning and issue of materials. Many related transactions are sometimes necessary between the submission of a requisition and the receipt of the material. Related actions such as the furnishing of supply status information, followup requests, redistribution orders, referral orders, and cancellation requests are all an integral part of the MILSTRIP system.

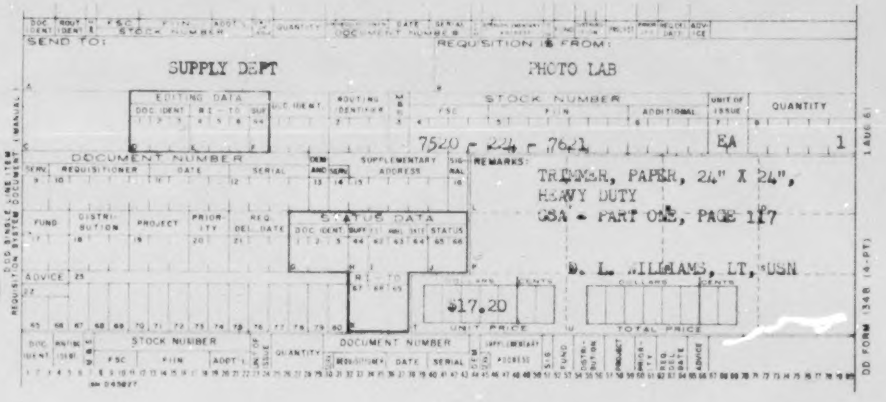
Speed is essential for effective supply support in today's Navy where the availability of complex weapon systems is of primary importance. MILSTRIP facilitates the use of data processing and electrical transmission while remaining compatible with manual processing procedures.

MILSTRIP employs two forms for the requisitioning and issuing of material. The Single Line Item Requisitioning Document (Form DD 1348) is the basic request document submitted to the applicable supply echelon for material requirements. The issue document is the Single Line Item Release/Receipt Document (Form 1348-1). Form DD 1348-1 is also used to return RFI material to the supply system.

The MILSTRIP requisition form normally used by the Photographer's Mate is the six-part, DD Form 1348.

NAVAL SUPPLY SYSTEMS COMMAND PUBLICATION 437

The NavSup Publication 437 promulgates policy and procedures relative to the Military Standard Requisitioning and Issue Procedure and the Military Standard Transaction Reporting and Accounting Procedures (MILSTRIP/MILSTRAP). This publication covers MILSTRIP/MILSTRAP procedures relative to supply system management, requisitioning ashore,



SEND TO:
SUPPLY DEPT

REQUISITION IS FROM:
PHOTO LAB

STOCK NUMBER: 7520 - 224 - 7621

UNIT OF ISSUE: EA

QUANTITY: 1

REMARKS:
TRIMMER, PAPER, 24" X 24",
HEAVY DUTY
GSA - PART ONE, PAGE 117

D. L. WILLIAMS, LT, USN

UNIT PRICE: $17.20

EDITING DATA
DOCUMENT NUMBER
STATUS DATA
TOTAL PRICE
ADVICE
DD FORM 1348 (4-PT)
1 AUG 61
DOD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT (MANUAL)

PH.382

Figure 3-7.—MILSTRIP requisition DD Form 1348.

inventory control, financial matters, material movement priorities, and evaluation procedures (MILSTEP). This publication provides forms, formats, codes, and serves as a comprehensive ready reference for those involved in the preparation and/or processing of MILSTRIP documents.

NavSup Publication 437 is not distributed afloat. All alfoat MILSTRIP/MILSTRAP procedures are incorporated into the NavSup Publication 485.

Paragraph numbering in this publication is similar to that of the NavSup Manual. Paragraph 06120-3.a is broken down as follows:

06 120 3a
Chapter — 06
Paragraph — 120
Subparagraph — 3a

NavSup Pub 437 is composed of loose pages suitable to three-ringed binders. Changes are published periodically as required and are incorporated in the same manner as NavSup Manual changes.

MILSTRIP/MILSTRAP DESK GUIDE (NAVSUP P-409)

Since NavSup P-437 is a comprehensive publication, filling three 2-inch binders, the MILSTRIP/MILSTRAP Desk Guide, NavSup P-409 was published to serve as a handy reference for personnel respeonsible for originating and processing MILSTRIP and MILSTRAP documents. This small booklet contains those common definitions, coding structures and abbreviated code definitions used on a day-to-day basis. Blank space is provided for entering commonly used routing identifier, fund, project, and locally assigned codes.

FLEET USE OF MILSTRIP (NAVSUP P-410)

NavSup P-410 serves the same purpose as the desk guide (NavSup P-409) for fleet personnel. In addition, it is designed to be used for indoctrination and training of fleet personnel in MILSTRIP procedures. It is larger (55 8-inch by 10-inch pages) than the desk guide (36 4½-inch by 6½-inch pages) and contains illustrations and explanations, making it a valuable training aid as well as a handy reference.

Self-Service Store (SERVMART)

Self-service stores are a relatively recent innovation in the Navy supply system and are in a continuing state of improvement and simplification.

SERVMART's eliminate the need for formal itemized request documents. Normally, a "credit card" is issued to the photographic supply PO, as required, to draw necessary supplies.

The SERVMART stocks items for which there is a constant demand. These items are individually marked and displayed in counter-high bins for convenient self-service selection. Issue accountability is recorded by means of a cash register type sales slip which must be returned to the photographic activity along with the credit card.

RETAIL ISSUE ORGANIZATIONS

Photographer's Mates are apt to encounter a variety of local requisitioning channels, all designed to present a demand for an item to the supporting supply department. Local instructions normally promulgate detailed procedures for submitting your demand to the appropriate supply point.

At times it will be necessary to purchase items directly from local suppliers. There are many rules and regulations governing this procedure, and they are not treated here. Such procurements are generally limited to items used in an emergency, or items which are not stocked in the Navy supply system; they must also meet certain cost limitations.

As a general rule, a requisition is submitted to the local supply department citing all necessary descriptive information and a suggested source of supply. The local supply department then prepares the appropriate documents and makes the actual purchase from the commercial supplier.

Retail issue organizations are inclusive of self-service stores (SERVMART), ready supply stores, and shop stores. The basic difference is in the internal supply recording procedures. Initial stocking of ready issue outlets is normally based on the applicable initial outfitting lists and the recommendations of the supported activity. Subsequent to initial stocking, replenishment is based on stock status factors.

Photographer's Mates come in contact with ready issue outlets most frequently when procuring office supplies. The ready issue outlet organization normally provides for ready access to the store by material consumers with a minimum of intermediate channels. The most popular type is the self-service type operation called the SERVMART which employs a credit card to minimize processing individual request documents and permit periodic summary of issues. This store is commonly referred to as "the country store."

ACCOUNTABILITY

Accountability, as covered in this section of the chapter, refers to the accountability for plant property and that required for photographic material.

All material, both equipage and supplies owned by the Navy, is identified by an accountability code. Accountability codes are assigned to material issued to operating units to indicate the degree of accountability required on each item. The senior Photographer's Mate is required to aid in accounting for all Navy-owned property allotted to his activity. It is the responsibility of the photographic officer to maintain property records for all accountable property issued to the photo lab or unit. Guidelines and instructions concerning accountability and disposition of photographic equipment can be found in NavAirInst 10700.2.

PLANT PROPERTY

"Plant Property" is the term used in the Navy to describe all Navy-owned real property, inclusive of that which is not owned but for which accountability is or becomes the responsibility of the Navy.

For management, fiscal, and technical purposes, all plant property items are divided into four classes as follows: Class 1—land; Class 2—buildings and improvements; Class 3—equipment (other than industrial production equipment); and Class 4—industrial production equipment.

The Photographer's Mate is more concerned with Class 3—equipment. The term "equipment" includes equipment of a capital nature other than industrial production equipment and meeting criteria established in Volume 3 of the Navy Comptroller Manual. Examples of this type equipment in a photo lab would be typewriters, adding machines, etc. Custody records must be maintained for this material throughout its in-use life, the originals of which are maintained by the fiscal officer.

The degree of accountability required for aeronautical material may be ascertained by the Material Accountability Recoverability Codes (MARC's). The MARC's appear in the descriptive sections and parts lists sections of the ASO Navy Stock List, NavAir Allowance/Initial Outfitting Lists, and in other publications as directed by NavAir.

REGULATIONS PERTAINING TO THE UNAUTHORIZED ISSUE OF EQUIPMENT

There are two major reasons for safeguarding Navy property. First and most important is the fact that all Navy material (especially aviation spare parts and equipment) has a strategic value to the Nation's military efforts; that is, the material is in stock to support aircraft having a mission which is an element or part of the Navy's mission. Secondly, all Navy material represents an investment of public funds (money belonging to the people collectively) and is entrusted to those responsible for its safeguarding. Anyone who willfully allows material under his charge to be damaged or lost, or fails to take the proper precautions against the possible damage or loss of such material, is culpable and subject to disciplinary action under the UCMJ. It should not be merely the threat of possible reprimand or disciplinary action that should motivate the PH to safeguard stores assigned to him. Rather, his patriotism and loyalty to his country, and his appreciation of the trust placed in him, should make him want to protect the Navy's property as well as he would his own.

The situations described in the following paragraphs involve unauthorized issues and/or improper procedures:

1. Giving Navy property to an individual for his personal (nonofficial) use. Under normal circumstances no one, regardless of his rank, has the power to authorize the giving away of Navy property. In the case of shipwreck survivors and other disaster victims, the commanding officer may authorize the issue of certain essential health and comfort items. Such issues must be itemized, expended from records and accounts (money value), and reported to higher authority.

2. Loaning Navy property to an individual for his personal use. The fact that he might have obtained a custody receipt for the item does not make this any more acceptable.

STOCK CONTROL

The prime function of stock control is to insure the availability of materials in the proper amount, at the proper place, and at the proper time. To accomplish this end, continuous and judicious management of materials must be exercised.

Records must be properly maintained to insure the accountability of materials, to provide a ready reference for determining the stock position, and for reports reflecting accurate information to the Navy inventory managers to provide for future support.

PHOTOGRAPHIC INVENTORY TRAN[illegible]

NavAir Instruction 10700.2A contains guide lines and instructions concerning the accountability, disposition, and inventory control of photographic and photographic interpretation equipment. The inventory manager of photographic and photographic interpretation equipment used within the Naval establishment is the Commander Naval Air Systems Command, whose responsibility extends through the development, procurement, allocation, and control of equipment.

To provide NavAirSysCom with effective management of the dispersed and rapidly changing inventory of photographic supplies and equipment, and to insure that photographic laboratories both ashore and afloat are properly equipped, an automatic system was developed. The accurate operation of this system depends upon:

1. The correctness of the input data used to create the initial data base.

2. The timeliness, correctness, and completeness of updating inputs sent from field activities to the data base maintained by NAVAIR.

All photographic laboratories in the Naval Establishment are responsible for providing timely and accurate information regarding their respective photographic equipment.

Changes in the condition or location of equipment described in enclosures 3 and 4 of NavAir Inst 10700.2A are to be submitted to the Commander Naval Air Systems Command, no later than 1 week after the change of condition or location occurs, on NavAir Form 10700/2. (See fig. 3-8.)

The following general rules govern the submission of inventory and change reports:

1. The parent command reports both its own and detachment's equipment.

2. Ships report only their own equipment, not that belonging to squadrons or detachments.

3. Equipment on loan is reported by the owner activity.

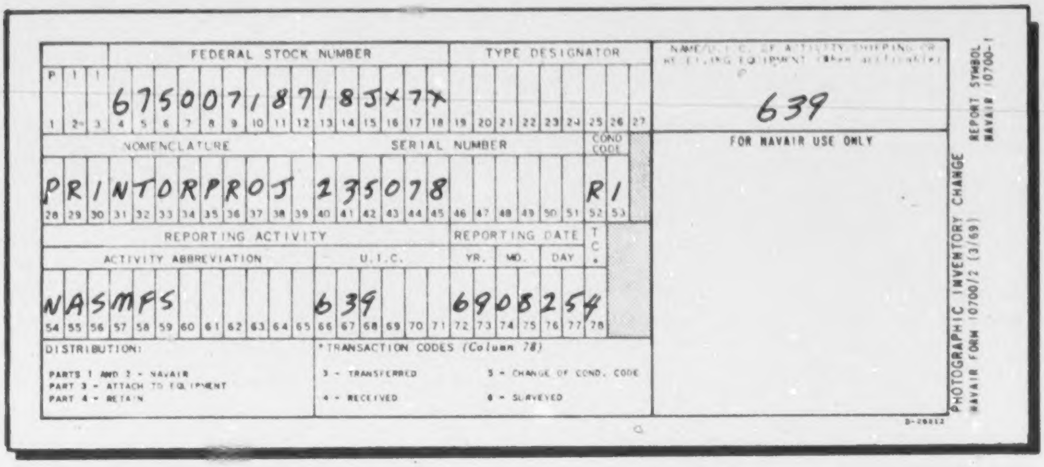
Detailed procedures for preparing the Photographic Inventory Change (NavAir Form 10700/2) are given in NavAirInst 10700.2A.

STOCK RECORD CARDS

The Photographer's Mate is concerned with four different forms in establishing and maintaining an official stock record for each item carried. These forms are the Stock Record Card (NavSup Form 766), the Stock Status and Replenishment Card (NavSup Form 767), the Stock Record Card Insert (NavSup Form 768), and the Stock Record Card Afloat (NavSup Form 1114).

A stock record card (NavSup Form 766) is the official record of all receipt and expenditure transactions and contains the current stock balance of each item carried in stock. All receipts, expenditures, inventory adjustments, and demands are on the applicable stock record card. Figure 3-9 illustrates a stock record card containing typical transaction entries.

Sensitized materials should have a separate card under each stock record card for different emulsion numbers and expiration dates. In this way, the oldest material is used first.



PHOTOGRAPHIC INVENTORY CHANGE
NAVAIR FORM 10700/2 (3/69)
REPORT SYMBOL NAVAIR 10700-1

P 1 1
FEDERAL STOCK NUMBER: 67500718718JX7X
TYPE DESIGNATOR:
NAME/U.I.C. OF ACTIVITY SHIPPING OR RECEIVING EQUIPMENT (When applicable): 639
NOMENCLATURE: PRINTORPROJ
SERIAL NUMBER: 235078
COND CODE: R1
REPORTING ACTIVITY
ACTIVITY ABBREVIATION: NASMFS
U.I.C.: 639
REPORTING DATE: YR. 69 MO. 08 DAY 25
T.C.*: 4
FOR NAVAIR USE ONLY

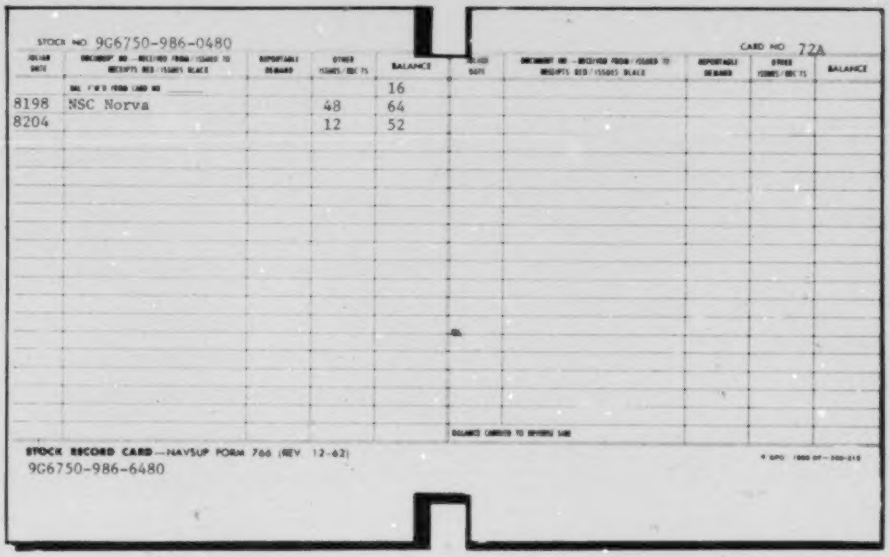
DISTRIBUTION:
PARTS 1 AND 2 - NAVAIR
PART 3 - ATTACH TO EQUIPMENT
PART 4 - RETAIN

*TRANSACTION CODES (Column 78)
3 - TRANSFERRED
4 - RECEIVED
5 - CHANGE OF COND. CODE
6 - SURVEYED

D-20812

PH.8

Figure 3-8.—Photographic inventory change form NavAir 10070/2.



STOCK NO 9G6750-986-0480 CARD NO 72A

JULIAN DATE	DOCUMENT NO.—RECEIVED FROM / ISSUED TO RECEIPTS RED / ISSUES BLACK	REPORTABLE DEMAND	OTHER ISSUES/REC'TS	BALANCE	JULIAN DATE	DOCUMENT NO.—RECEIVED FROM / ISSUED TO RECEIPTS RED / ISSUES BLACK	REPORTABLE DEMAND	OTHER ISSUES/REC'TS	BALANCE
	BAL. F'W'D FROM CARD NO ____			16					
8198	NSC Norva		48	64					
8204			12	52					

BALANCE CARRIED TO REVERSE SIDE

STOCK RECORD CARD—NAVSUP FORM 766 (REV. 12-62)
9G6750-986-6480

PH.383

Figure 3-9.—Stock Record Card (NavSup Form 766).

A stock record card contains the following information:

1. Stock number of material: This can be located in Aviation Catalog WEL0067, WEL0068, WEL0069, or DSA 6750 group [illegible]og.

2. Card no: The initial card on each item is card number one with each card put in behind the first card numbered consecutively.

3. Date: The Julian date on which the material is issued or received.

4. Document number: The stub or invoice number under which the material is received.

5. Received from/Issued to: All receipts are entered in red ink, all issues entered in black ink.

6. Reportable demand: The quantity expended requiring replacement for continued operations.

7. Other issues/Rec'ts: Non-replenishment issues and receipts for example items that are not consumable.

8. Balance: The amount remaining after issues and receipts have been accounted for.

A Stock Status and Replenishment Card (NavSup Form 767) maintained for each item in stock serves a dual purpose. The left side of the card is used to assemble stock status data preparatory to replenishment action and serves as a historical record of such data. The right portion of the card is divided into two sections: ordered and received. It serves as a record of replenishment actions and shows the status of all expected receipts. (See fig. 3-10.)

A Stock Status and Replenishment card contains the following information on the left side:

1. Stock number: Obtained in the same manner as stock number on stock record card.

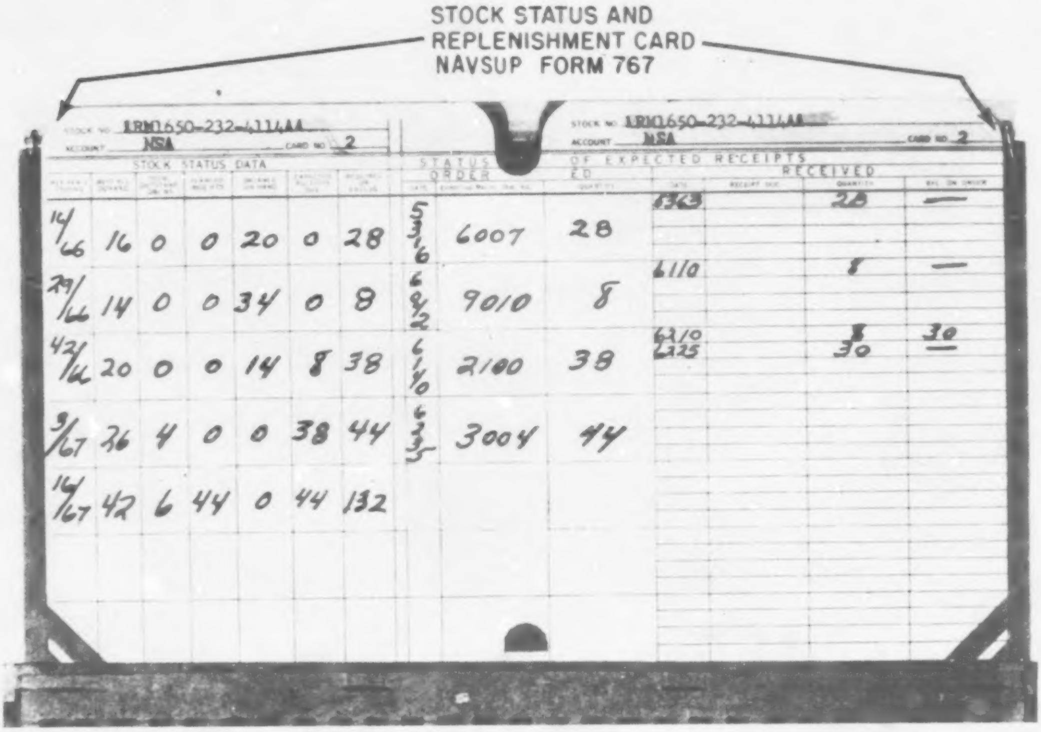
2. Account: Either APA or NSA as appropriate.

3. Card number: Obtained in same manner as indicated for stock record card.

4. Replenishable period ending: The end of the quarter. The upper number indicates the number of the week, the lower number the year.

5. Reportable demand: The replenishment demand or amount expended for the preceding period.

6. Total outstanding obligations: Definite obligations for supplying other activities; defi-



STOCK STATUS AND
REPLENISHMENT CARD
NAVSUP FORM 767

STOCK NO. 1RM1650-232-4114AA
ACCOUNT NSA
CARD NO. 2

STOCK STATUS DATA / STATUS OF EXPECTED RECEIPTS ORDERED

STOCK STATUS DATA							ORDERED		
14/66	16	0	0	20	0	28	5316	6007	28
29/66	14	0	0	34	0	8	6092	9010	8
42/66	20	0	0	14	8	38	6140	2100	38
9/67	26	4	0	0	38	44	6335	3004	44
14/67	42	6	44	0	44	132			

RECEIVED			
5363		28	—
6110		8	—
6210		8	30
6225		30	—

AK.102

Figure 3-10.—Stock Status and Replenishment Card (NavSup Form 767).

nite obligations needed for an increase in work load.

7. Planned requirement: Estimated amounts needed to supply other activities; estimated amounts needed for a predicted increase in work load.

8. Balance on hand: The amount left in stock after issues.

9. Expected receipts due: Items that are on order.

10. Required or excess: Amount to order; amount in excess of that which is needed (any excess amount is circled). To determine the amount of excess or required material the following method can be utilized:

a. Determine the amount that will be required for the next quarter. Add the reportable demand to the total outstanding obligations.

b. Add the balance on hand to the expected receipts.

c. Determine the amount by subtracting the second total from the first total. If the second total is greater than the first total, there is an excess and material will not be ordered.

The following information is provided on the right side (Status of Expected Receipts, Ordered):

1. Date: The Julian date that the stub was submitted.

2. Expected Receipt Document No: The stub number of the item on order.

3. Quantity: The amount ordered.

The following information is provided on the right side (Status of Expected Receipts, Received):

1. Date: Julian date that the material was received.

2. Receipt document: If different from ordered receipt document number.

3. Quantity: If different from ordered quantity.

4. Balance on order: Amount not yet received.

5. In case the order has been cut or split there are four lines per order for this purpose.

A Stock Record Card Insert (NavSup Form 768) contains the identifying information of stock items and serves as an index to the stock record card. All information necessary for filling in the card can be found in the ASO supply catalogs, Series WEL0067, WEL0068, WEL0069, NavSupSysCom Manual Volume II, and NavSup Publication 485. (See fig. 3-11.)

A Stock Record Card Afloat (NavSup Form 1114) is maintained on board ships operating under manual stock control procedures. Stock record cards may be prepared by hand or by typewriter in accordance with the format printed on the form. Identifying information is inserted on the top and bottom line of the NavSup form as illustrated by figure 3-12.

The stock record card afloat provides for the recording of replenishment actions, material receipts, and material expenditures and reflects a running balance of the stock on hand.

As requisitions are prepared, they are posed to the "requisitions outstanding" block of the NavSup Form 1114. The Julian date of the requisition, the document number, and the quantity ordered are entered in the appropriate columns.

High and Low Limits

In order to insure that ships have on board at all times a well-rounded stock of material necessary to sustain operations for a maximum period of time, effective stock management must be rigidly maintained for all items in stock.

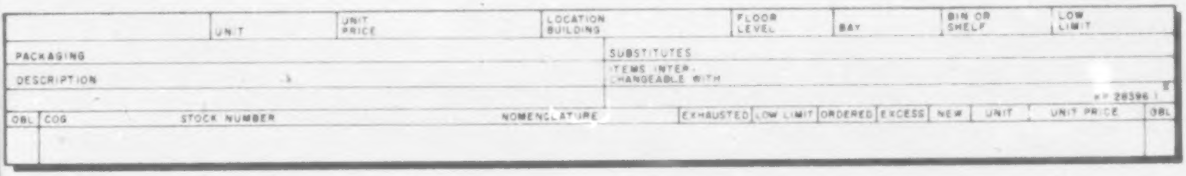
The terms high and low limit apply to quantity entries on the stock record card afloat to identify the maximum and minimum levels of stock to be maintained to support the ship's mission.

The HIGH LIMIT of a stock item is synonymous with the requisitioning objective; that is, the safety level, plus the operating level, plus the quantity which would normally be required during the ordering and shipping time. A high limit is not assigned to items of stock in allowance quantities of two or less.

The LOW LIMIT of a stock item is the safety level plus the quantity of material expected to be consumed during the order and shipping time. The low limit entry for all items in which the allowance is two or less is the allowed quantity, and replenishment is initiated each time an issue is made.

Stock Records Replenishment Review

The stock records are reviewed at the time receipts and expenditures are posted. The balance on hand is visually checked against the low limit. Items that are approaching or have reached the low limit are flagged, in the manner determined locally, to indicate that replenishment is required at the first opportunity. At the earliest possible time, replenishment requisitions are prepared and submitted to the designated supporting supply point. The material should be ordered in sufficient quantities to bring the material on hand and on order up to the high limit.



UNIT	UNIT PRICE	LOCATION BUILDING	FLOOR LEVEL	BAY	BIN OR SHELF	LOW LIMIT

PACKAGING

SUBSTITUTES

DESCRIPTION

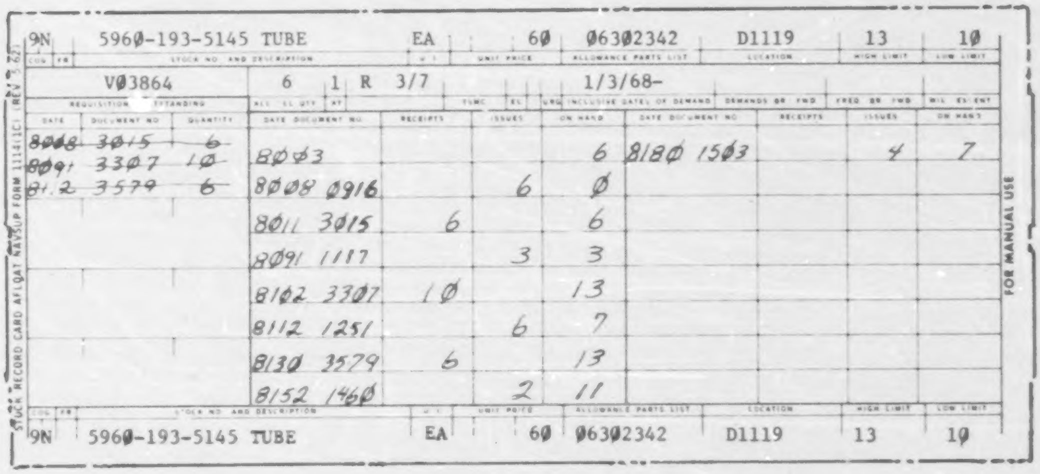
ITEMS INTERCHANGEABLE WITH

KP 28396 I

OBL	COG	STOCK NUMBER	NOMENCLATURE	EXHAUSTED	LOW LIMIT	ORDERED	EXCESS	NEW	UNIT	UNIT PRICE	OBL

PH.384

Figure 3-11.–Stock Record Card Insert (NavSup Form 768).



STOCK RECORD CARD AFLOAT NAVSUP FORM 1114(1C) (REV 3-62)

9N	5960-193-5145 TUBE	EA	60	06302342	D1119	13	10
COG	STOCK NO. AND DESCRIPTION	U/I	UNIT PRICE	ALLOWANCE PARTS LIST	LOCATION	HIGH LIMIT	LOW LIMIT

V03864 | 6 | 1 | R | 3/7 | 1/3/68-

REQUISITION OUTSTANDING: DATE	DOCUMENT NO	QUANTITY	DATE DOCUMENT NO	RECEIPTS	ISSUES	ON HAND	DATE DOCUMENT NO	RECEIPTS	ISSUES	ON HAND
~~8008~~	~~3015~~	~~6~~	8003			6	8180 1503		4	7
~~8091~~	~~3307~~	~~10~~	8008 0916		6	0				
~~8102~~	~~3579~~	~~6~~	8011 3015	6		6				
			8091 1117		3	3				
			8102 3307	10		13				
			8112 1251		6	7				
			8130 3579	6		13				
			8152 1460		2	11				

COG	STOCK NO. AND DESCRIPTION	U/I	UNIT PRICE	ALLOWANCE PARTS LIST	LOCATION	HIGH LIMIT	LOW LIMIT
9N	5960-193-5145 TUBE	EA	60	06302342	D1119	13	10

FOR MANUAL USE

AK.107

Figure 3-12.—Stock Record Card Afloat (NavSup Form 1114).

Established high and low limits may also require adjustment if usage data indicates. Table 3-5 illustrates how high and low limits are determined. Table 3-5 is based on a stock item with a past usuage rate of 100 each per month.

In addition, which a ship receives orders for deployment or underway replenishment, the stock records are reviewed to insure that all stocks are replenished as near to the high limit as possible.

Particular attention should be paid to stock records of critical items. They should be flagged appropriately to facilitate frequent review and replenishment. The following categories of items are classed as critical relative to replenishment review procedures:

1. Fast moving items having lower safety levels than desired because of stowage limitations or shelf life.
2. All items the lack of which would seriously impair operations.

Table 3-5.—Determining quantity levels of supply.

Level of supply	Months	Appropriate quantity
1. Safety level	2	200
2. Operating level	6	600
3. Stocking objective (1 + 2)	8	800
4. Order and shipping time	1	100
5. Requisitioning level or high limit (3 + 4)	9	900
6. Low limit (1 + 4)	3	300

Requisition Logbook

The Requisition Logbook accomplishes two purposes: First, it serves as a ready reference for material on order; and second, it serves as a record of material received. This book should contain columns for the requisition number, stock number, nomenclature, quantity ordered, unit price, total cost, date ordered, date received, local supply department requisition number (for requests going off station), UR number, and amount received. These columns can be varied to meet local needs. It is noted that due to the volume of business and numerous customers at any given supply department, matters requiring followup on outstanding requisitions are more efficiently handled if the PH knows the supply requisition number.

Pre-Expended Bin Method of Handling Supplies

Another suggested method of handling office supplies which are of a consumable nature is to use in effect the pre-expended bin system. In this system all supplies would be kept in a central location. Each month needed supplies would be issued for the operation of the office for that month. This can be determined by past usage data. The supplies are considered to be pre-expended. Then, the inventory of supplies remaining in the central storeroom is made and future requirements based on this inventory are ordered. Adjustments would have to be made periodically, but this system can help to maintain a balanced and adequate stock of high usage items on hand. Since the quantity is for 30 days only, and adequate lead time is required for ordering of supplies, this is not considered to be overstocking.

INVENTORY

The term inventory, as used by Photographer's Mates, applies to the total amount of an item physically within the photographic spaces and under the control of the photographic officer.

Inventory aboard ship is necessary to insure that ships have a well-rounded stock of material on board at all times to sustain operations for a maximum period of time. In order to do this, effective inventory procedures must be maintained rigidly for all items in stock.

Inventory ashore is equally as important as aboard ship. At shore stations, the quantity of material on hand will normally conform to the station allowances prescribed by applicable allowance lists.

Knowing which catalog and requisition form to use is important, but just as important is knowing when to order your supplies. This can be accomplished only by using a definite system or procedure which includes inventories, logbooks, and stock record cards.

The findings of physical inventories serve to verify that the stock records are correct, or lead to their correction if discrepancies are encountered. Briefly, periodic inventories are taken for the following reasons:

1. To determine quantities of stock on hand for comparison with stock record balances.
2. To determine the difference between actual physical count and stock record card balances.
3. To ascertain the causes of these differences.
4. To provide data for planning against recurrence of these differences.
5. To prepare a correct money value trial balance of each segment of stock which is used to adjust the current financial inventory control ledger balance.

The most important aspect of physical inventory is that it provides a check to insure that material presumed to be in stock is actually there and is available when needed. The false security created by an erroneous balance on the stock record card is extremely serious. A zero balance, for instance, may be rectified by timely procurement action. However, if the zero balance is unknown, until a demand is presented, a serious delay may be encountered. Physical inventories aid in keeping this condition to a minimum.

INVENTORY OF CONTROLLED EQUIPAGE

All items of controlled equipage, including custody signature required items, are inventoried annually during the month of March. Deficiencies are reported to the type commander in the BUDGET/OPTAR report in accordance with current instructions. Inventories are also required when any of the following situations occur:

1. The ship is commissioned, inactivated, or reactivated.
2. Upon relief of the head of department (inventory required only for those items in the department concerned).
3. Upon change of command at the discretion of the relieving commanding officer. When a complete inventory has been taken during the

past 12 months, the annual inventory requirement is satisfied.

The file of duplicate copies of Equipage Stock Card and Custody Record (NavSup Form 306 or 460), maintained by the head of the department, is usually used to conduct the equipage inventory. Each article is sighted and inspected for serviceability by the inventorying officer. Articles identified by serial number are checked by those numbers when inventories are taken.

As the inventory progresses, or immediately after completion, the inventory recorded on the duplicate NavSup Form 306/460 is transcribed to the original maintained by the supply department. (See fig. 3-13.) Any shortages or unserviceable nonaviation items found during the inventory must be covered by a Survey Request, Report, and Expenditure (NavSup Form 154). All equipage inventories must be completed within 30 days after date of commencement. When taken jointly by the relieved and relieving head of department, the inventory should be completed prior to detachment of the outgoing head of department.

Upon completion of the equipage inventory, the department head submits a letter to the commanding officer and a copy to the supply officer. When possible, the letter is a joint report from the relieved and relieving head of department and both officers sign the report. The report includes the following information:

1. The department equipage inventory has been completed.
2. Required requests for issues and survey have been submitted for shortages and unserviceable items found during the inventory or the reasons why they have not been submitted.

CUSTODY CARDS

For each item of equipage requring custody signature, you must have an Equipage Stock Card and Custody Record, NavSup Form 306 or Form 460, signed opposite the quantity on board by the present division officer/department head. This form is generally referred to merely as a "custody card."

The Material Accountability Recovery Code (MARC) will indicate if custody is required.

The original and at least one copy of the custody card should be prepared by the local supply office for each item of equipment requiring custody signature. The original is kept by the supply office, and the copy is maintained in the department files. For plant account items requiring custody signature (typewriters, adding machines, etc.) the operations administrative branch usually keeps the copy. For photographic items requiring custody signature, the copy is usually maintained on a subcustody basis in the photo lab. In the case of the latter items, the photographic officer will make periodic sight inventories of the items in his custody, but in all cases the relieving photo officer should physically sight and sign for custody of this material.

Cards for each department are numbered in a separate series designating the department.

The other items on the card are self explanatory. Refer to figure 3-13 for an example of the Equipage Stock Card and Custody Record, NavSup Form 460. If more than one item is allowed and one is surveyed, it must be reflected on the entries on the card.

SURVEY

A survey is the procedure required by Navy Regulations when Navy property must be expended in one of the following ways:

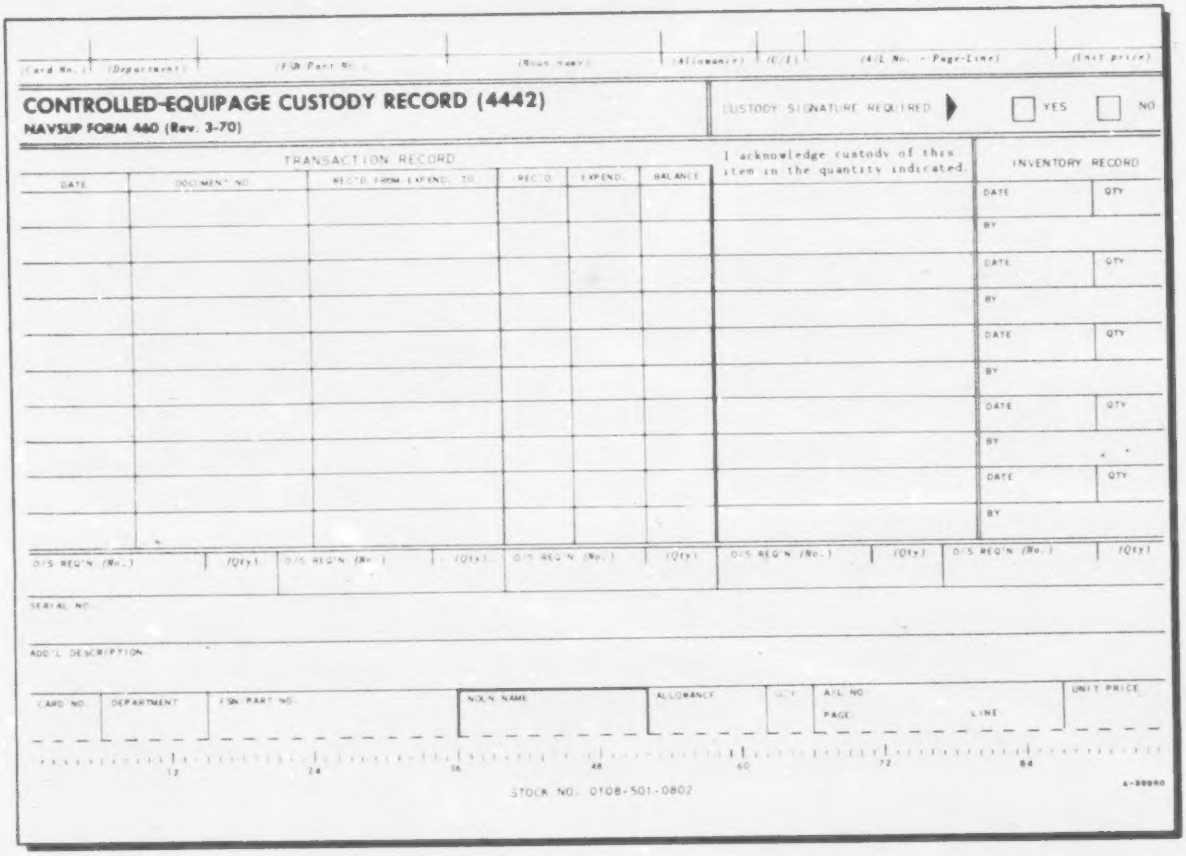
1. Condemned as a result of damage, obsolescence, or deterioration.
2. Appraised as a result of loss of utility.
3. Acknowledged as nonexistent as a result of loss or theft, necessitating the expenditure of the accountable material from the records of the holding activity.

The purpose of the survey is to provide a record for the following:

1. An administrative review of the condition of the material, the responsibility therefor, and the recommendation for disposition.
2. An authorization to expend the material from the records on which carried.
3. An authorization to decrease the monetary value in store.
4. An authorization to transfer the material having a sales value from the regular federal group to the property disposal account.

TYPES OF SURVEYS

A FORMAL survey is required for those classes of materials or articles so designated by



(Card No.) (Department) (FSN Part No.) (Noun name) (Allowance) (U/I) (A/L No. - Page-Line) (Unit price)

CONTROLLED-EQUIPAGE CUSTODY RECORD (4442)
NAVSUP FORM 460 (Rev. 3-70)

CUSTODY SIGNATURE REQUIRED ☐ YES ☐ NO

TRANSACTION RECORD

DATE	DOCUMENT NO.	REC'D FROM/EXPEND. TO	REC'D	EXPEND.	BALANCE

I acknowledge custody of this item in the quantity indicated.

INVENTORY RECORD

DATE	QTY
BY	
DATE	QTY
BY	
DATE	QTY
BY	
DATE	QTY
BY	
DATE	QTY
BY	

O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty)

SERIAL NO.

ADD'L DESCRIPTION

CARD NO. DEPARTMENT FSN PART NO. NOUN NAME ALLOWANCE U/I A/L NO. PAGE LINE UNIT PRICE

12 24 36 48 60 72 84

STOCK NO. 0108-501-0802

PH.385

Figure 3-13.—Equipage Stock Card and Custody Record (NavSup Form 460).

the bureau or office concerned, or when specifically directed by the commanding officer. A formal survey is made by either a commissioned officer or a board of three officers, one of whom (and as many as practicable) must be commissioned officers. The commanding officer appoints officers to serve on survey boards.

Neither the commanding officer, the officer on whose records the material being surveyed is carried, nor the officer charged with the custody of the material being surveyed, may serve on a survey board.

INFORMAL surveys are made by the head of the department having custody of the material to be surveyed. Informal surveys are used in all cases (except flight clothing) when a formal survey is not required or directed by the commanding officer.

Material may be expended without survey on a DD Form 1149 which has been annotated "Loss by survey" and indicating the circumstances of the loss or damage or disposition authority thereon in circumstances including the following:

1. Material is short, damaged, or lost in shipment by commercial carrier, government conveyance, or air or regular parcel post and the value of the loss is less than $10 per bill of lading, cargo document, invoice, or other form of shipping document.

2. The value of material lost as a result of physical deterioration, damage by handling, fire,

water, or other similar circumstances is less than $100 per line item.

3. Items determined to be scrap by an inventory manager.

4. Losses less than $100 which are the responsibility of the following shippers:

   1. Defense Supply Agency.
   2. General Services Administration.
   3. Army.
   4. Air Force.

PHASES OF SURVEY PROCEDURES

The survey procedure is composed of the following phases:

1. Request for survey.
2. Action by the commanding officer on the request for survey.
3. Preparation of the survey report.
4. Action by the reviewing officer, normally the commanding officer, on the survey report.
5. Expenditure of the material from the records on which carried or transfer to the property disposal account when recommended by the survey report and approved by the reviewing officer.

In many cases, when command policy is well established, certain phases are performed simultaneously. For example, phases 1 and 3 could be completed (if it is known in advance that the CO wants an informal survey) followed by steps 2 and 4, thereby eliminating the double routing of the survey through the CO. This should become clearer as we discuss each of the phases in the following paragraphs.

Request For Survey

The survey request may be originated by any department, division, or section head, or by a designated subordinate as prescribed in local regulations. Normally, the survey request is originated in the department having custody of the material to be surveyed.

ROUGH REQUEST.–The initial survey request will be made in rough on a Survey Request Report and Expenditure (NavSup Form 154) except for material lost or damaged in shipment by commercial carriers. In the latter event, the Discrepancy in Shipment Report (Standard Form 361) is used. NavSup Manual, paragraph 25160-3, gives complete information on this subject. Included on or attached to the initial survey request must be a statement of the opinion of the originator relative to the following:

1. The condition of the material.
2. The cause or condition surrounding the loss, damage, deterioration, or obsolescence of the material.
3. The responsibility for the cause or condition if such can be determined or, if the responsibility cannot be determined the reason why it cannot be determined.
4. A recommended disposition of the material and the action to be taken.

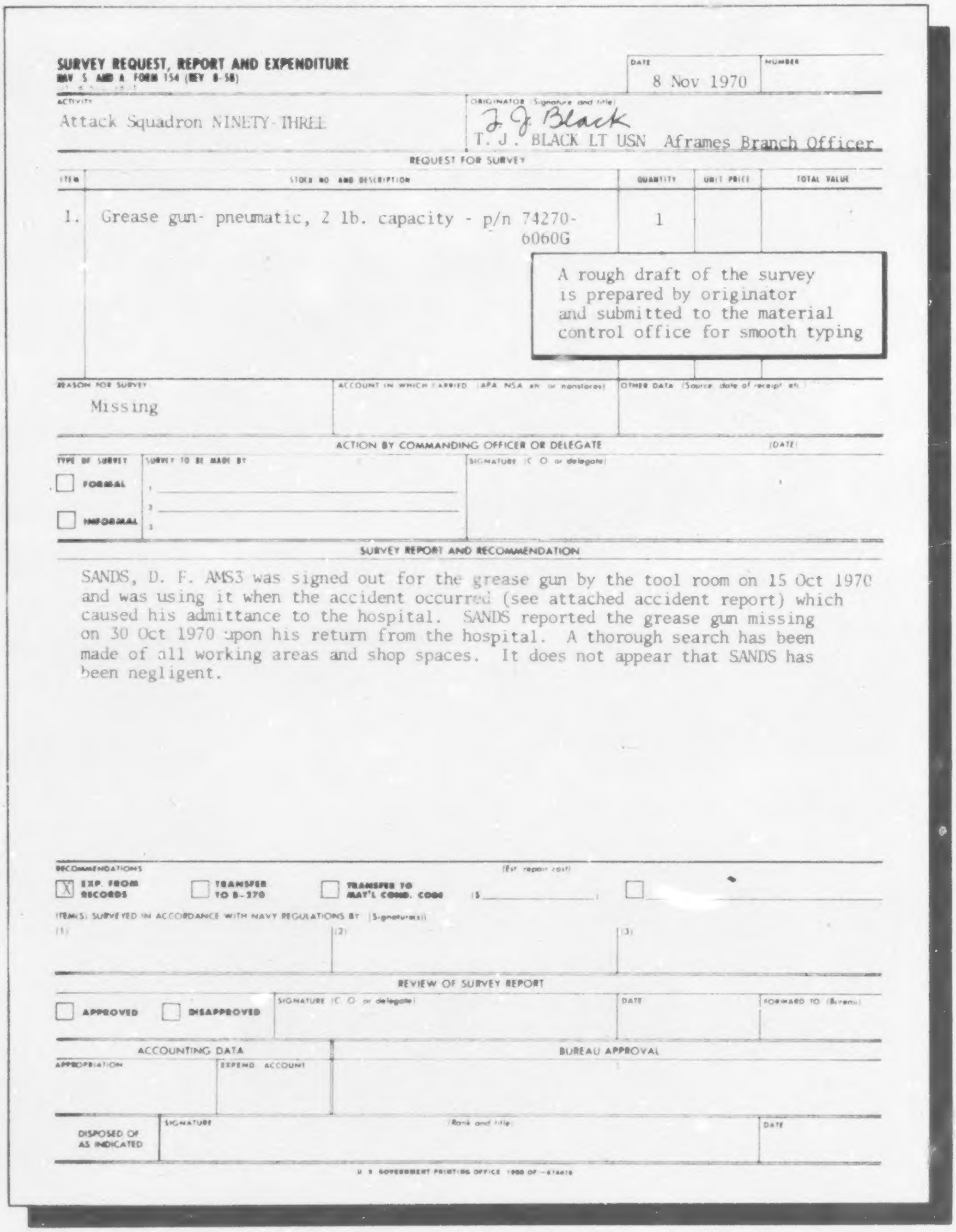
The description of the material should be as complete as possible and should include the serial numbers of the items involved, if applicable. In addition, pertinent references to bureau, command, or office manuals or other directives that specifically require formal survey or special disposition of surveyed material will be made on the initial request. The initial survey request is not considered as the survey report but is used as a guide to the commanding officer in determining the type of survey to be held and as an aid to the surveying officer, board, or head of department in the preparation of the survey report. Figure 3-14 is an example of a rough request for survey.

SMOOTH REQUEST.–As prescribed by local regulations, the initial survey request is forwarded to a designated group or section, normally within the supply department, which is charged with the responsibility for preparing the smooth survey request.

The designated group or section will prepare the smooth survey request on NavSup Form 154 or Standard Form 361 in the number of copies required for distribution (usually the original and six copies; see the paragraph on distribution).

The person submitting the initial rough request for survey signs the original of the smooth request for survey as the originator.

The smooth survey request is prepared from information obtained from the initial survey request supplemented by such information as is available from supply department records. Such information includes the date and the name of



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV S AND A FORM 154 (REV 8-58)

DATE: 8 Nov 1970
NUMBER:

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T. J. Black
T. J. BLACK LT USN Aframes Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	Grease gun- pneumatic, 2 lb. capacity - p/n 74270-6060G	1		

A rough draft of the survey is prepared by originator and submitted to the material control office for smooth typing

REASON FOR SURVEY: Missing
ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores):
OTHER DATA (Source, date of receipt, etc.):

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY: ☐ FORMAL ☐ INFORMAL
SURVEY TO BE MADE BY: 1 ______ 2 ______ 3
SIGNATURE (C. O. or delegate)

SURVEY REPORT AND RECOMMENDATION

SANDS, D. F. AMS3 was signed out for the grease gun by the tool room on 15 Oct 1970 and was using it when the accident occurred (see attached accident report) which caused his admittance to the hospital. SANDS reported the grease gun missing on 30 Oct 1970 upon his return from the hospital. A thorough search has been made of all working areas and shop spaces. It does not appear that SANDS has been negligent.

RECOMMENDATIONS
☒ EXP. FROM RECORDS ☐ TRANSFER TO S-270 ☐ TRANSFER TO MAT'L COND. CODE (Est. repair cost) ($______) ☐ ______

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY (Signature(s))
(1) (2) (3)

REVIEW OF SURVEY REPORT
☐ APPROVED ☐ DISAPPROVED
SIGNATURE (C. O. or delegate) DATE FORWARD TO (Bureau)

ACCOUNTING DATA
APPROPRIATION EXPEND. ACCOUNT
BUREAU APPROVAL

DISPOSED OF AS INDICATED SIGNATURE (Rank and title) DATE

U S GOVERNMENT PRINTING OFFICE 1960 OF—474416

AK.124

Figure 3-14.—Rough request for survey.

the activity from which the material was received, the invoice number, and the value of the material. Figure 3-15 is an example of a smooth survey request.

The statement of the opinion of the originator relative to the condition, cause, responsibility, and recommendation is not typed on the smooth survey request. However, this statement is appended to the original of the smooth survey request and labeled "Originator's statement" to prevent its possible confusion with the survey report as prepared by the designated surveying officer, board, or head of department. After preparation, the smooth survey request is forwarded to the commanding officer or his representative for action.

Action by the Commanding Officer

Upon receipt of the smooth survey request, the commanding officer or his representative determines whether a formal or an informal survey is appropriate. This decision is entered in the original copies of the smooth survey request. In the case of formal surveys, the smooth survey request is forwarded to the surveying officer or board as designated by the commanding officer for accomplishment of the survey report section of the Survey Request Report and Expenditure (NavSup Form 154) or the Discrepancy in Shipment Report (Standard Form 361).

In the case of informal surveys, the smooth survey request is forwarded to the head of the department having custody of the material to be surveyed for accomplishment of the survey report section of the NavSup Form 154 or the Standard Form 361. The action by the commanding officer is illustrated in figure 3-16.

Preparation of the Survey Report

The surveying officer, board, or head of department makes a thorough inspection of the material being surveyed to determine its condition at the time of survey or, if missing, a thorough examination of the circumstances attending the loss, and fixes the cause and responsibility therefor or, when responsibility cannot be fixed, makes a statement showing clearly why such cannot be done.

A full report is made on Survey Request, Report and Expenditure (NavSup Form 154) or on the Discrepancy in Shipment Report (Standard Form 361) in the report section. This report includes the findings as to condition, cause, and responsibility and a recommendation as to disposition, replacement, or continuance in service. The recommendation for disposition must be specific and in accordance with the NavSup Manual, paragraph 25160-4.

The supply department is usually responsible for the smooth preparation of the report section of the survey from information furnished by the surveying officer or board. Figure 3-17 illustrates an example of the completion of the report section. The survey officer or officers sign the report section of the smooth survey which is then forwarded to the commanding officer for review.

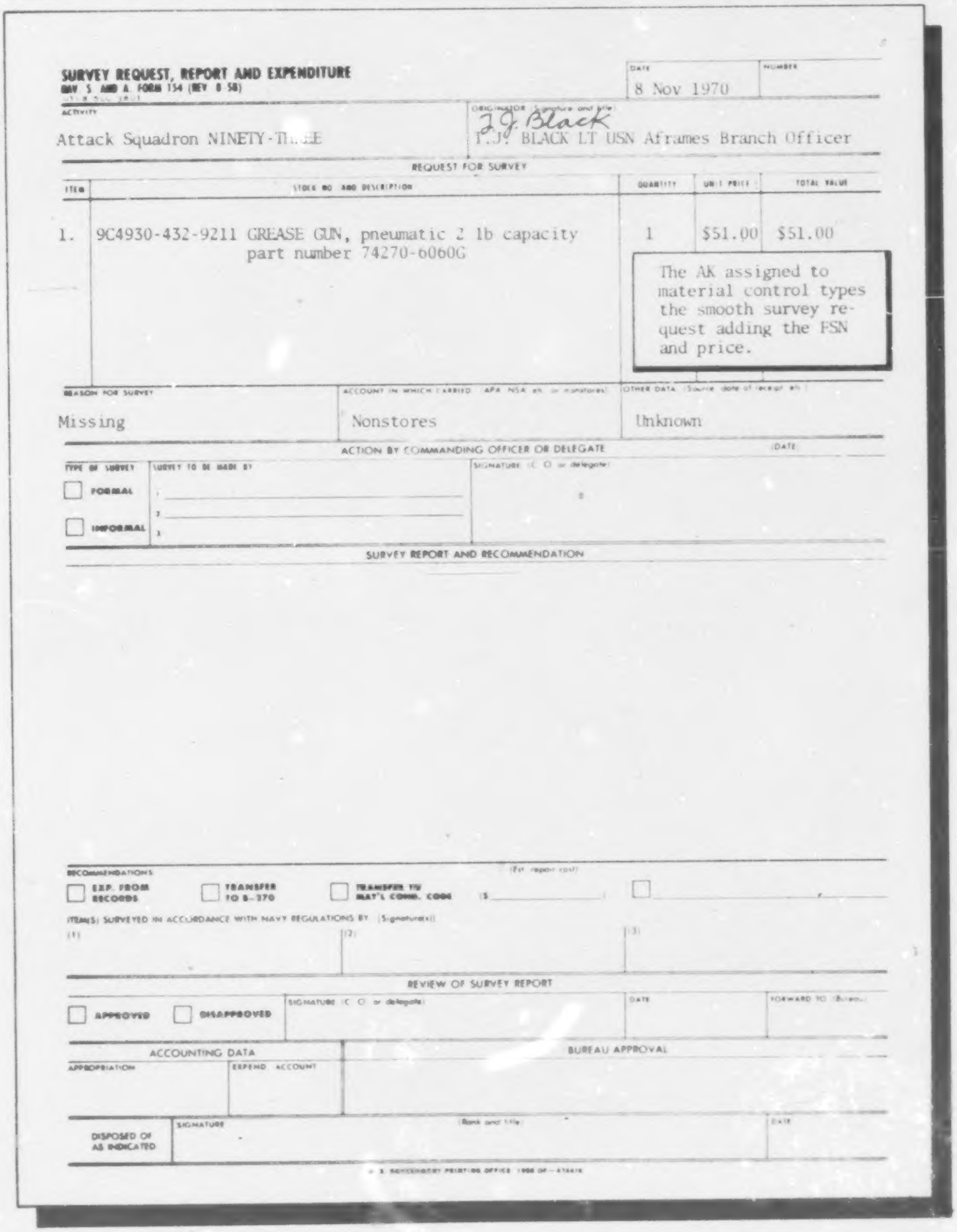
Action by the Reviewing Officer

After action by the surveying officer, board, or head of department, the survey report is submitted for review to the commanding officer or the officer ordering the survey, if the survey was ordered by higher authority. When the reviewing officer does not approve the action of the surveying officer, board, or head of department, he causes another survey to be held on the material. In all cases the second survey must be formal. If the reviewing officer does not approve the findings of the second survey, the matter must be referred to the bureau, command, or office having cognizance over the material.

Survey Expenditure

Upon receipt of the properly approved Survey Request, Report and Expenditure (NavSup Form 154) or the Discrepancy in Shipment Report (Standard Form 361), the officer carrying the surveyed material on his records completes the expenditure section except when the material has disposal value and the material is to be transferred to the property disposal account.

Appropriate expenditure data is entered on the Standard Form 361, and the accounting data or appropriation to which the proceeds of claim



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV 8-58)

DATE: 8 Nov 1970
NUMBER:

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T.J. Black
T.J. BLACK LT USN Aframes Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

The AK assigned to material control types the smooth survey request adding the FSN and price.

REASON FOR SURVEY: Missing

ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores): Nonstores

OTHER DATA (Source, date of receipt, etc.): Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY: ☐ FORMAL ☐ INFORMAL

SURVEY TO BE MADE BY:
1
2
3

SIGNATURE (C. O. or delegate)

SURVEY REPORT AND RECOMMENDATION

RECOMMENDATIONS: ☐ EXP. FROM RECORDS ☐ TRANSFER TO S-270 ☐ TRANSFER TO MAT'L COND. CODE (Est. repair cost) ($) ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY (Signature(s))
(1)
(2)
(3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED

SIGNATURE (C. O. or delegate)

DATE

FORWARD TO (Bureau)

ACCOUNTING DATA

APPROPRIATION

EXPEND. ACCOUNT

BUREAU APPROVAL

DISPOSED OF AS INDICATED

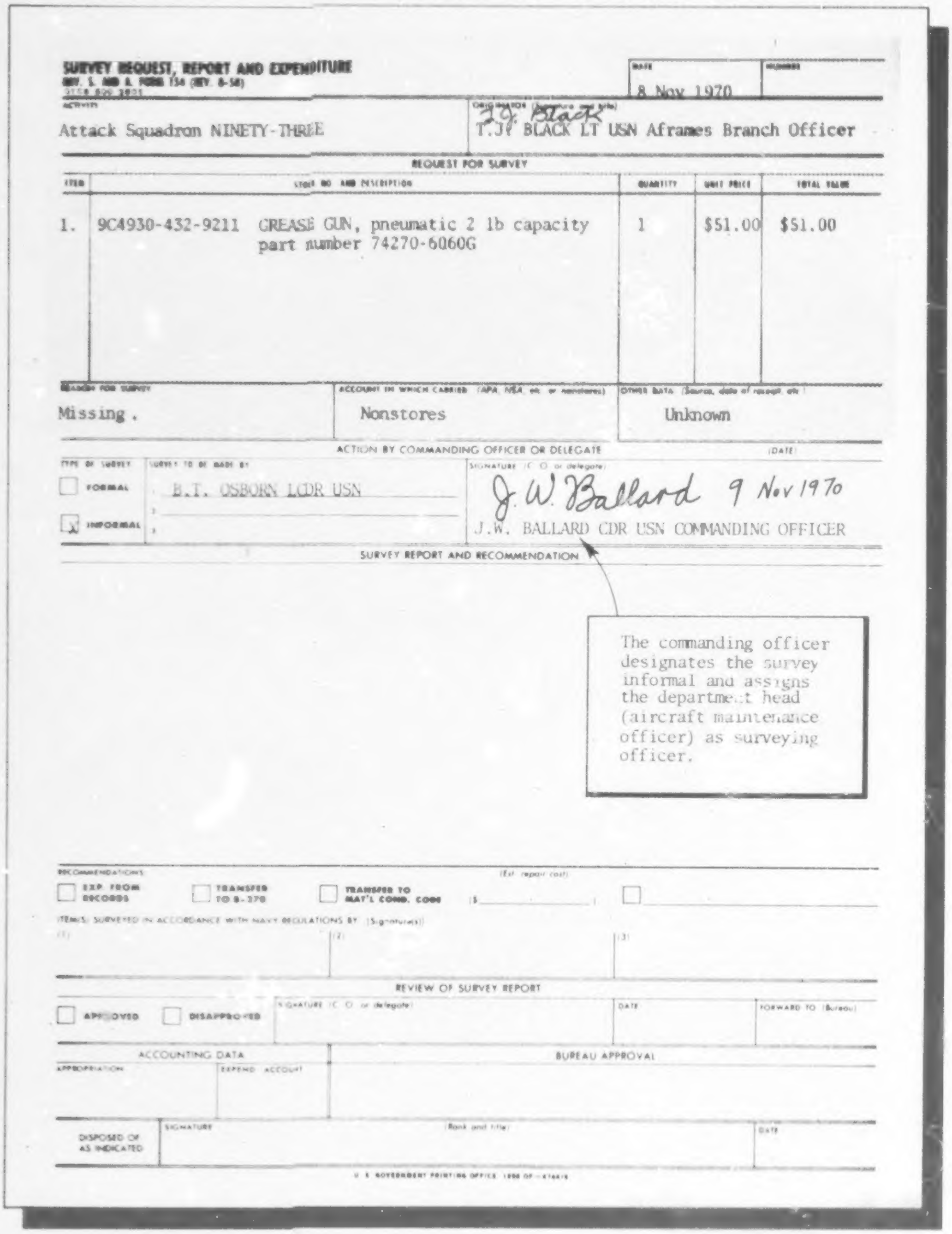
SIGNATURE

(Rank and title)

DATE

AK.125

Figure 3-15.—Smooth survey request.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE	8 Nov 1970
NUMBER	
ACTIVITY	Attack Squadron NINETY-THREE
ORIGINATOR (Signature and title)	T.J. Black T.J. BLACK LT USN Aframes Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores)	OTHER DATA (Source, date of receipt, etc.)
Missing.	Nonstores	Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY	SURVEY TO BE MADE BY	SIGNATURE (C. O. or delegate)
☐ FORMAL ☒ INFORMAL	1. B.T. OSBORN LCDR USN 2. 3.	J. W. Ballard 9 Nov 1970 J.W. BALLARD CDR USN COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

The commanding officer designates the survey informal and assigns the department head (aircraft maintenance officer) as surveying officer.

RECOMMENDATIONS:
☐ EXP. FROM RECORDS ☐ TRANSFER TO S-270 ☐ TRANSFER TO MAT'L COND. CODE (Est. repair cost) ($) ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: (Signature(s))
(1) (2) (3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED	SIGNATURE (C. O. or delegate)	DATE	FORWARD TO (Bureau)

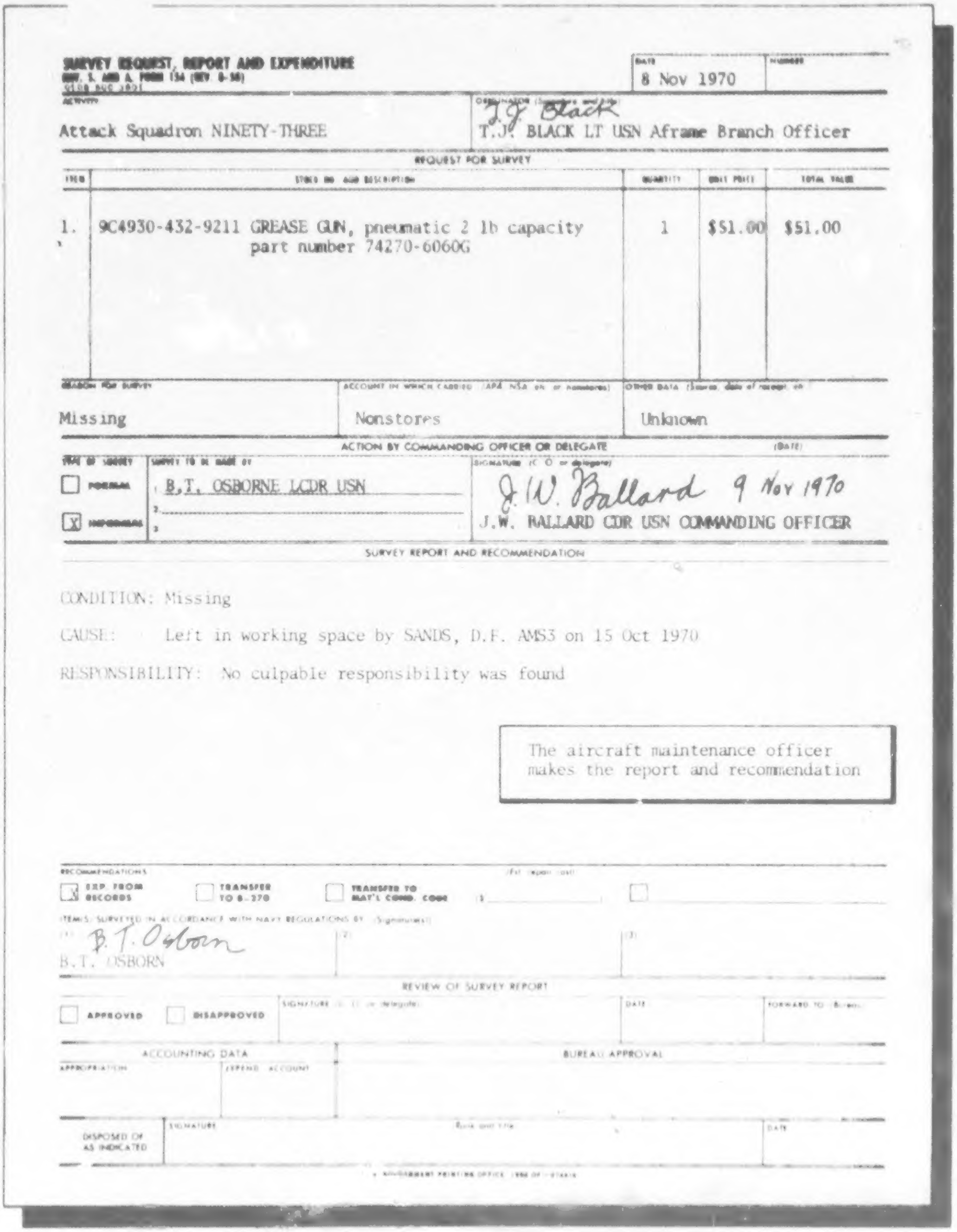
ACCOUNTING DATA		BUREAU APPROVAL
APPROPRIATION	EXPEND. ACCOUNT	

DISPOSED OF AS INDICATED	SIGNATURE	(Rank and title)	DATE

U. S. GOVERNMENT PRINTING OFFICE

AK.126

Figure 3-16.—Action by the commanding officer on a survey.



SURVEY REQUEST, REPORT AND EXPENDITURE

DATE: 8 Nov 1970

Attack Squadron NINETY-THREE

T.J. Black
T.J. BLACK LT USN Aframe Branch Officer

REQUEST FOR SURVEY

1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

Missing

ACCOUNT IN WHICH CARRIED (APA NSA or nonstores): Nonstores

OTHER DATA: Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE

☐ FORMAL

☒ INFORMAL

1 B.T. OSBORNE LCDR USN

2

3

SIGNATURE (C.O. or delegate): J.W. Ballard

(DATE): 9 Nov 1970

J.W. BALLARD CDR USN COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

CONDITION: Missing

CAUSE: Left in working space by SANDS, D.F. AMS3 on 15 Oct 1970

RESPONSIBILITY: No culpable responsibility was found

The aircraft maintenance officer makes the report and recommendation

RECOMMENDATIONS

☒ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE $ ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY (Signatures)

(1) B.T. Osborn
B.T. OSBORN

(2)

(3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED

SIGNATURE (C.O. or delegate)

DATE

FORWARD TO (Bureau)

ACCOUNTING DATA

APPROPRIATION

EXPEND. ACCOUNT

BUREAU APPROVAL

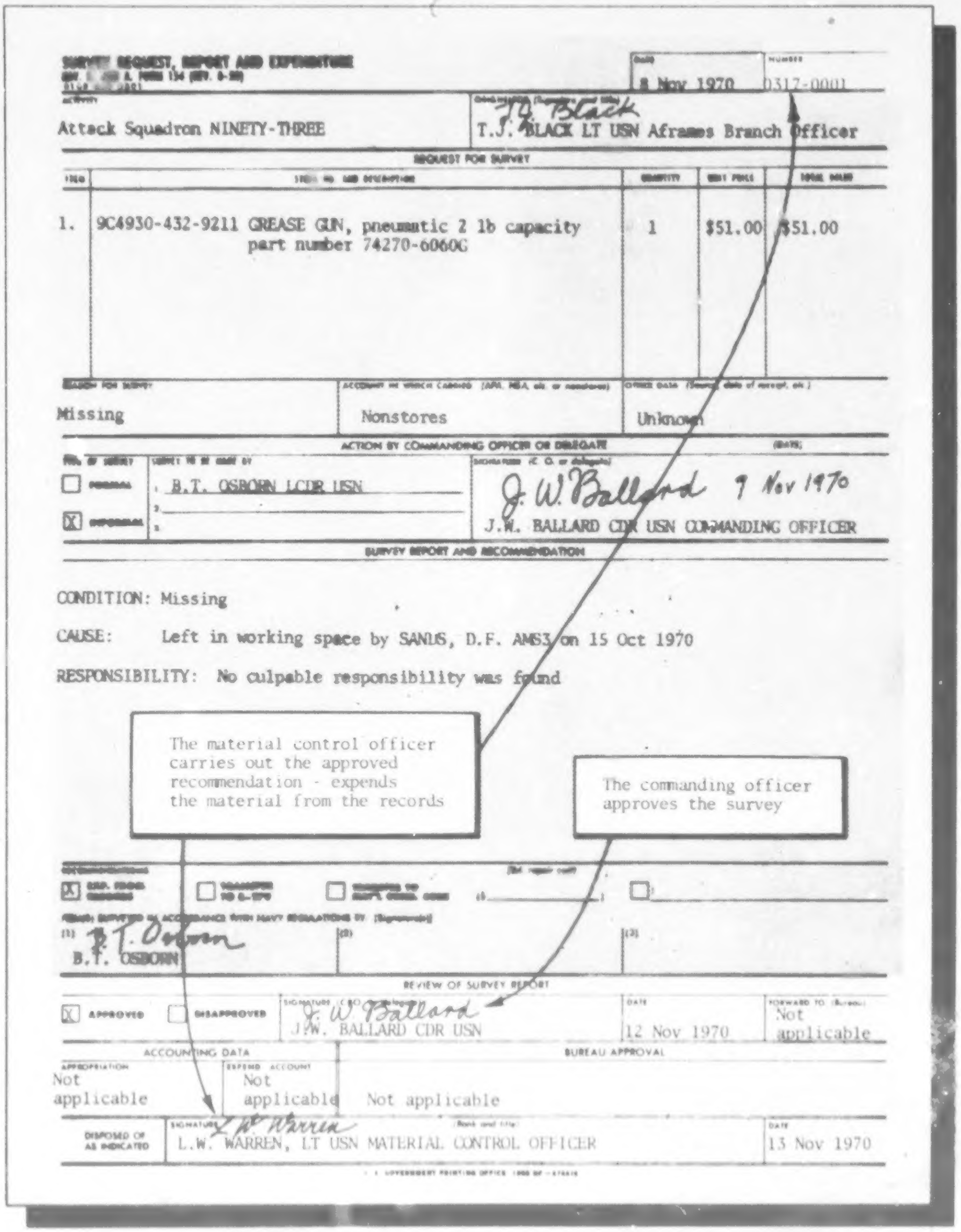
DISPOSED OF AS INDICATED

SIGNATURE

DATE

AK.127

Figure 3-17.—Completion of report section of a survey.



SURVEY REQUEST, REPORT AND EXPENDITURE

DATE	8 Nov 1970
NUMBER	0317-0001
ACTIVITY	Attack Squadron NINETY-THREE
ORIGINATOR	T.J. Black T.J. BLACK LT USN Aframes Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED	OTHER DATA
Missing	Nonstores	Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

☐ FORMAL
☒ INFORMAL

1. B.T. OSBORN LCDR USN
2.
3.

SIGNATURE (C. O. or delegate): J. W. Ballard 9 Nov 1970
J.W. BALLARD CDR USN COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

CONDITION: Missing

CAUSE: Left in working space by SANUS, D.F. AMS3 on 15 Oct 1970

RESPONSIBILITY: No culpable responsibility was found

The material control officer carries out the approved recommendation - expends the material from the records

The commanding officer approves the survey

☒ EXP. FROM RECORDS ☐ ☐ ☐

(1) B.T. Osborn
B.T. OSBORN
(2)
(3)

REVIEW OF SURVEY REPORT

☒ APPROVED ☐ DISAPPROVED	SIGNATURE (C.O. or delegate) J. W. Ballard J.W. BALLARD CDR USN	DATE 12 Nov 1970	FORWARD TO (Bureau) Not applicable

ACCOUNTING DATA		BUREAU APPROVAL
APPROPRIATION Not applicable	EXPEND ACCOUNT Not applicable	Not applicable

DISPOSED OF AS INDICATED	SIGNATURE L W. Warren (Rank and title) L.W. WARREN, LT USN MATERIAL CONTROL OFFICER	DATE 13 Nov 1970

AK.128

Figure 3-18.—Completed survey.

action should be ultimately credited is entered in the appropriate item. The NavSup Form 154 or Standard Form 361 is assigned a number in the regular expenditure invoice series. If the material is not to be expended from the records but is to be transferred to the property disposal account, transfer is accomplished on NavSup Form 154 or Standard Form 361 without filling in any part of the expenditure section. Figure 3-18 illustrates an example of the completed survey.

DISTRIBUTION OF SURVEYS

Copies of a survey are distributed as follows:

1. One copy to the originator of the survey request.
2. One copy to the surveying officer, board, or head of department.
3. The original and three copies to the officer carrying the surveyed material on his records except when the original is forwarded to a systems command or office for approval. (See item 4.)
4. The original to the cognizant systems command or office when required for final review and approval. The original is returned to the officer carrying the surveyed material on his records unless the systems command or Navy inventory manager requires an information copy approved by the commanding officer. In such cases, a copy is returned to the officer carrying the surveyed material on his records.
5. Any additional copies as required by local regulations.
6. One copy to the expenditure file.

CULPABLE RESPONSIBILITY

When a person in the naval service is found to be culpably responsible by a surveying officer or board, the reviewing officer refers the entire matter to such a person for a statement. The reviewing officer must then take such disciplinary action as the circumstances require. He notes on the survey form the action taken and informs the Chief of Naval Personnel and the systems command concerned as to the disciplinary action taken. In the case of officers, he must make recommendations as to the inclusion of a statement of the action taken in the record of the person concerned and inform such person of the final decision in the matter. Action on the survey in respect to the material involved is not, however, withheld pending disciplinary action.

CHAPTER 4

PORTRAITURE

Webster's definition of a portrait as "a pictorial representation of a person, especially the face" is not a very eloquent description. It does bring out one essential point: It emphasizes a person rather than his environment or something associated with his activity. However, a pictorial representation which succeeds only in obtaining a recognizable likeness of the person leaves much to be desired. A striking portrait is one in which the personality and the mood of the subject are revealed. It interprets that personality, psychologically as well as visually, to an inspiring degree to the observer.

Portraiture is one of the most challenging phases of photography, but it is also one of the most rewarding. A successful portrait requires a thorough understanding of the photographic techniques involved, a definite artistic ability, and the talent of directing the subject into a pleasing and/or characteristic expression through the photographer's own mental attitude and interest in people.

Portrait photographers vary considerably in their style and techniques while the personal likes and dislikes of the subjects will also vary. Therefore, there is no blueprint or formula which will insure success in the field of portraiture. By skillful variations of lighting and posing, a picture may either portray a mood of gaiety or solemnity. It may be dramatic, truthful, or glamorous, depending on the motive of the photographer and his ability to effectively display that mood on film.

There have been hundreds of articles written on the subject of portraiture. In each case the author explains his particular methods, illustrates his lighting technique and discusses at great length the problems of posing. These articles are alike in one respect only—the story of how to make a portrait. It appears that no other field of photography is so diversified in opinions, techniques, cameras, and lighting equipment as portraiture. However, some guides are appropriate to assist in developing a talent for taking portraits. There are a few "never do it this way" or "always do it this way" rules in portraiture. Nevertheless the photographer must learn to sense or feel when the lighting, pose, and expression are right rather than depend on a set of rules resembling a recipe for making a cake. The most important factor in portraiture is the photographer himself—his psychological makeup, his sensitivity and understanding of people, and his developed capacity to observe significant characteristics and to exploit them photographically. He must be able to find or induce the expression which is most interpretive of the subject's personality.

CAMERAS AND ACCESSORIES

A wide variety of cameras is used in portrait photography, ranging from the 35mm to the 8 x 10. Many of these cameras are modified in some manner to make them more versatile for the particular individual.

One of the most desirable features in a camera for portraiture is a ground glass for composing the picture and for critical focusing. Here the reflex type camera has a definite advantage over the other types of cameras. The upright image makes the job of composing much easier. The image can also be checked for proper focus until the instant of exposure.

In order to make the camera more versatile, it should be equipped with at least two and possibly three lenses of different focal lengths. Depending on space limitations and the amount of figure to be included, the lens best suited for the job can then be selected.

Unless working space is limited, a short focal length lens should not be used. It requires placing the camera so close, in order to obtain a large image, that the figure is distorted and the subject becomes very camera-conscious. It further restricts the photographer from moving around freely in front of the camera to arrange the lights and pose the subject. A long focal length lens permits the camera to be set up at a convenient working distance from the subject and gives a much better perspective.

The use of the terms short, medium and long, as applied to the focal length of lenses, is purely relative in conjuction with the size of the film being used. The connotation is similar to that implied by the terms wide, normal, and narrow angle lenses.

For HEAD-AND-SHOULDER PORTRAITS, a long focal length lens is recommended; that is, one whose focal length is equal to or greater than the sum of the two adjoining sides of the film. With 4 x 5 inch film, the lens should be at least 9 inches focal length and with 8 x 10 inch film at least 18 inches. If a shorter lens is used, the camera will be too close to the subject and poor perspective will result. If working space permits, a longer lens should be used.

When making THREE-QUARTER or FULL-FIGURE PORTRAITS, the use of such a long focal length lens is neither necessary nor desirable. The distance between the camera and subject would be too great to be practical and would require a large studio. A medium focal length lens is more suitable for this type of portrait; that is, one having a focal length approximately equal to the diagonal of the film. This would be about 6 inches for 4 x 5 inch film and 12 inches for 8 x 10 inch film.

For HALF-FIGURE PORTRAITS, either a long or medium focal length lens will be satisfactory. Selection of the lens is at the discretion of the photographer and will depend to some extent on the available working space.

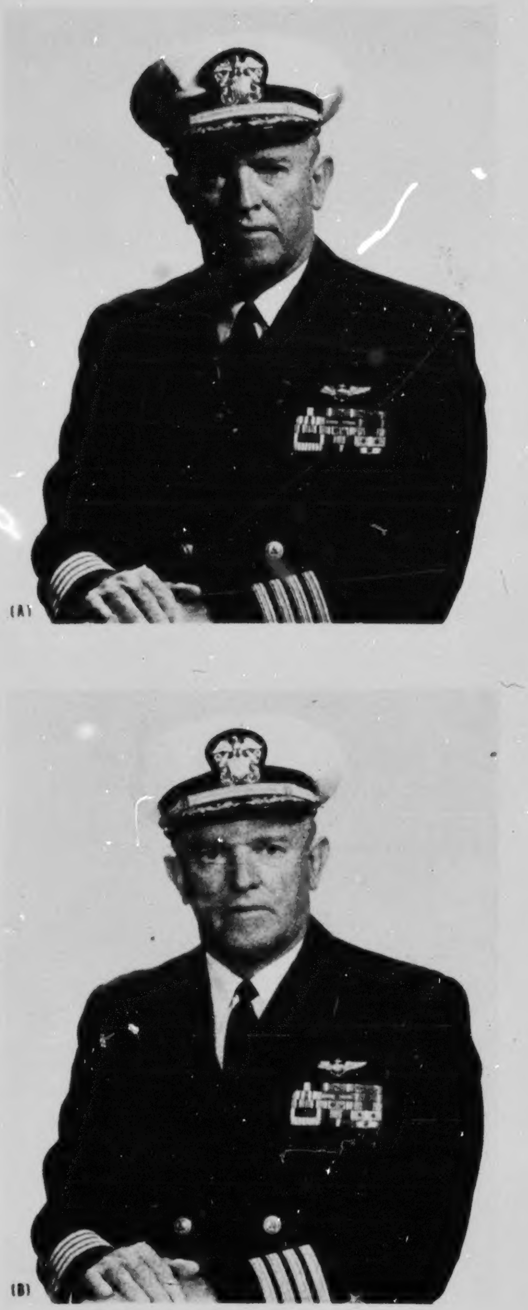
Under conditions of limited working space, it will be necessary to use a shorter lens than would normally be selected. A short focal length lens will cause near objects to appear larger than normal in comparison with more distant objects. When used close to the subject, there is a tendency to distort the proportions of the figure. However, by carefully posing the subject, distortion can be minimized and a more pleasing perspective obtained. If the view includes the subject's hands, keep them in the same plane as the body. If the body is turned very far away from the camera, the distant shoulder will appear much smaller than the one nearer the camera. The swing back of a view camera can be employed to assist in controlling distortion resulting from using a short focal length lens.

As with cameras and lenses, there are no specific requirements for shutters in portraiture. Some have certain advantages which make them more convenient to use under certain circumstances.

TYPES OF LIGHT USED

The quality of a portrait is dependent only to a very minor degree on the type of light used for illumination. Almost any light source may be used very effectively by an expert. Excellent portraits can be made indoors using daylight coming through windows as the only source of illumination. Simple lighting equipment such as reflector photofloods will do a commendable job, even in a color portrait. In fact, photofloods are very useful and convenient due to their portability and low current requirements. Sunlight, either direct or diffused, can be used successfully outdoors. Elaborate equipment, such as vent lights and spotlights may simplify the lighting problem. A portrait is a success or failure for one basic reason—whether or not it presents the subject in an intriguing and personable mood. The manner in which the subject is lighted contributes greatly to the success of a portrait, but good lighting can be achieved with simple, inexpensive equipment.

Two photoflood lamps will furnish adequate lighting for portraits of naval personnel. One is used as the main light source and is referred to as the modeling light, as shown in (A) of figure 4-1. It models the curvatures and characteristic features of the face with highlights and shadows, adding an apparent third dimension of depth to the picture. The other is used as a secondary light source and is called the FILL-IN LIGHT. Its purpose is simply to soften or fill in the shadow areas about the face, not to eliminate them, as shown in (B) of figure 4-1. Ordinarily the fill-in light is diffused and placed at such a



PH.386

Figure 4-1.—Use of modeling light. (A) Effect created by using modeling light; (B) effect created by adding fill-in light.

distance that its intensity on the subject is approximately one-half that of the modeling light. A simple reflector can be used instead of the fill-in light, placing it close to the subject to reflect light into the shadow areas from the main light source. (See fig. 4-1.)

Auxiliary lighting equipment, though not essential, will be of great assistance in solving the problem of achieving interesting, flexible lighting effects. Focusing spotlights are preferable to floodlights for auxiliary illumination because the beam width can be controlled to place the light exactly where it is wanted. By projecting a light on the background, shadows can be softened or eliminated and an additional feeling of depth obtained by preventing the subject from blending with the background. The background can be made to appear light or dark, as desired, by varying the intensity of illumination. An interesting effect can be obtained by projecting a circular or oval-shaped patch of light on the background directly behind the subject. This has the effect of darkening the corners of the picture to center more interest on the subject's face. (See fig. 4-2.)

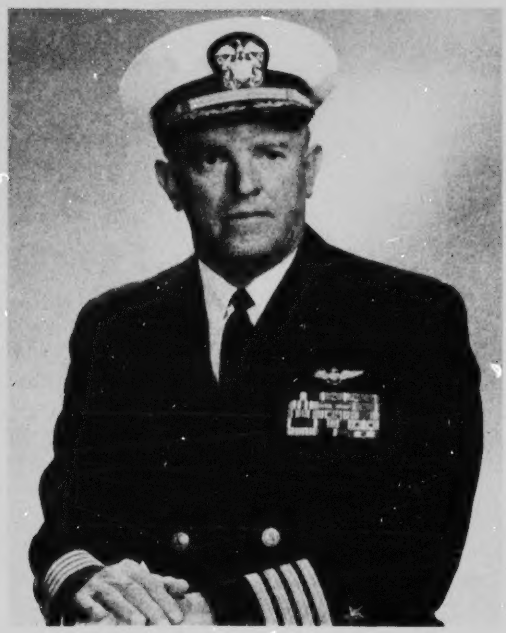
SHIPBOARD PORTRAITURE

Shipboard portraiture consists primarily of head and shoulder type portraits for BUPERS, local roster boards, and passports. Space for making portraits aboard ship is extremely limited and varies with each ship.

BACKGROUND

The background to be used for indoor portraits should be plain, without any pattern, figures, or designs of any type which attract the viewer's attention. The background should be of a matte surface to help prevent surface reflections.

An economical background, both practical and easily improvised, is not difficult to produce. A white or light gray blanket, light colored wall or a light canvas or lightweight muslin stretched over a frame and painted with a flat paint can be utilized. The paint colors most useful are white, neutral gray, light blue, or light green. These cooler colors with subdued tones are particularly suited for color portraits. They provide an added contrast between the skin



PH.387

Figure 4-2.--A floodlight at left and a spotlight at right produce these effects on the background.

tones of the subject and the background; furthermore, the visual effect of receding provides an additional third dimensional effect to the photograph. A background composed of a single bright color is unsuitable for color portraiture. Single bright colors are not only artistically of poor taste, but they have a tendency to overwhelm the color likeness of the subject. The background then becomes more noticeable than the subject.

POSING THE SUBJECT

A box, bench, stool, or low table will serve adequately as a posing bench. A chair is undesirable for several reasons. There is a tendency for the subject to lean against the back of a chair, resulting in a slumped attitude and bunching the clothing up at the back of the neck. The subject will sit more nearly erect without a backrest and the clothing will appear to fit much better. Further, the back of a chair sticking up in a picture is distracting, and it is difficult to pose the subject so as to keep the chair out of sight behind him. A very low posing bench will be uncomfortable, causing the subject's back to be arched and his knees too high in relation to the rest of the body. If the bench is 16 inches or higher, the subject will appear much more comfortable and alert.

When making a formal studio portrait, the subject should be placed a minimum of 6 feet from the background if sufficient working space is available; otherwise, objectionable shadows are likely to be cast on the background within the picture area. This distance allows sufficient working space behind the subject to permit the use of a back light or background light.

Except for identification photographs, the head and shoulders should be turned slightly away from the camera. If the subject's shoulders are squared to the camera and he is looking straight into the lens, the pose usually appears static and unattractive. A feeling of motion can be obtained by turning the body away from the camera, then turning the head back slightly toward or past the camera. The head-on shot tends to emphasize the subject's ears. Turning the head slightly will partially or completely conceal one ear and subordinate the other by making it appear to lie closer to the head.

Very few people are equally photogenic on both sides of the face. In nearly every case one side of the face will appear more pleasing and expressive than the other. Scars or other facial blemishes can be hidden by turning them away from the camera or can be subdued by keeping them in the shadows. Since people greatly desire to be flattered in a photograph, the objective of a portrait is to do the best job of flattery possible. The photographer then must pay particular attention to the subject to determine which side of the face should be favored, both by lighting and posing.

There are no rules to follow as to which way to turn the subject. Some photographers prefer a pose which places the side of the head on which the hair is parted nearer the camera. This is particularly effective with women since it appears to lengthen the face, and the part adds a line leading into the picture. A man with thin hair or a receding hairline, however, may appear almost bald when photographed from this side. It is mostly a matter of choice—yours and the subject's—as to which side presents the most flattering viewpoint photographically. If he prefers to turn in a particular direction, he will probably let it be known; otherwise, it is up to you to make the analysis and decide which pose will produce the most effective results.

Taking a portrait should not be a hurried, matter-of-fact, assembly line production. Do not seat the subject on the posing bench the minute he enters the studio. An unhurried preliminary conversation will pay dividends in better pictures. It will give you a chance to study the subject, decide on the type of lighting and best pose, and to put him at ease. Try to create and maintain a friendly, personal atmosphere. Talk with the subject about anything which may be of interest to him. As the conversation progresses, casually observe his expressions, mannerisms, and characteristics attitudes. Try too plan the picture before seating the subject on the posing bench.

It is a great asset to a photographer to know how to behave with different people, how to cultivate their good will and confidence, and put them in a relaxed, amiable mood. Some enjoy a good joke, others are more dignified and reserved. The photographer who can sense these attitudes and act accordingly has a much better chance of setting up a friendly relationship with the subject and obtaining better pictures. Never make unreasonable demands of the subject or insist that he do something to which he objects. The atmosphere will become tense and his confidence and cooperation impossible to obtain.

In planning the pose for the most effective portrait, one of the most important points to consider is the general appearance of the head, face, and neck. Through the medium of lighting, posing, and camera angle, the photographer can alter the apparent width of the face and length of the neck to a considerable extent. If the face is a normal, oval shape, it requires no special attention. An exceptionally round or long thin face can be greatly improved in appearance by proper lighting and posing. Knowing how to solve this problem will permit the photographer to decide exactly how to pose and light the subject before he is seated on the posing bench. This will prevent wasting a lot of time experimenting with the light and tiring the subject by turning him first one way then anothe

There are two corrective methods which can be used to make the broad, round face appear more slender. Either one may be used separately to improve the appearance, or the two combined for the maximum effect.

Placing the modeling light to one side of the subject at about ninety degrees to the axis of the lens will highlight one side of the face while the other side remains in shadow. If the subject is facing the camera directly, his face will be equally divided between highlight and shadow, making it appear more slender. Turning his head toward the modeling light will present much less of the distant cheek to the camera while the side nearer the camera remains mostly in shadow for the maximum slenderizing effect. When the subject is turned to one side, it is important to turn toward the modeling light in order to have the shadow side of the face nearer the camera. (See fig. 4-3.)

In many cases, a lower angle is advantageous in the slenderizing effect since it shows more of the neck. This is particularly effective when the subject also has a short, thick neck.

For the long, slender face, there are three corrective methods which can be used to improve the appearance. The modeling light can be placed near the camera to evenly illuminate as much of both sides of the face as possible while still showing some modeling of the nose. In this case, shadows on the side of the face should be minimized. By facing the subject almost directly at the camera, nearly all of both sides of the face are presented to make it appear less slender. A high camera angle is also very effective in foreshortening the long, thin face, making it appear more normal (except when the subject is bald). Quite often, a slender-faced person will also have a long, thin neck. The high camera angle also makes the neck appear considerably shorter.

The full profile view is seldom used except on women. However, some people will either a wide or slender face may have a very good profile; in which case, do not overlook the possibility of making a very flattering portrait in profile. The excessive width or slenderness of a face is much less apparent when viewed from the side.

Before seating the subject, suggest that he may like to check his appearance in a mirror. Combing the hair, straightening the tie, setting the hat at the proper angle, and smoothing out

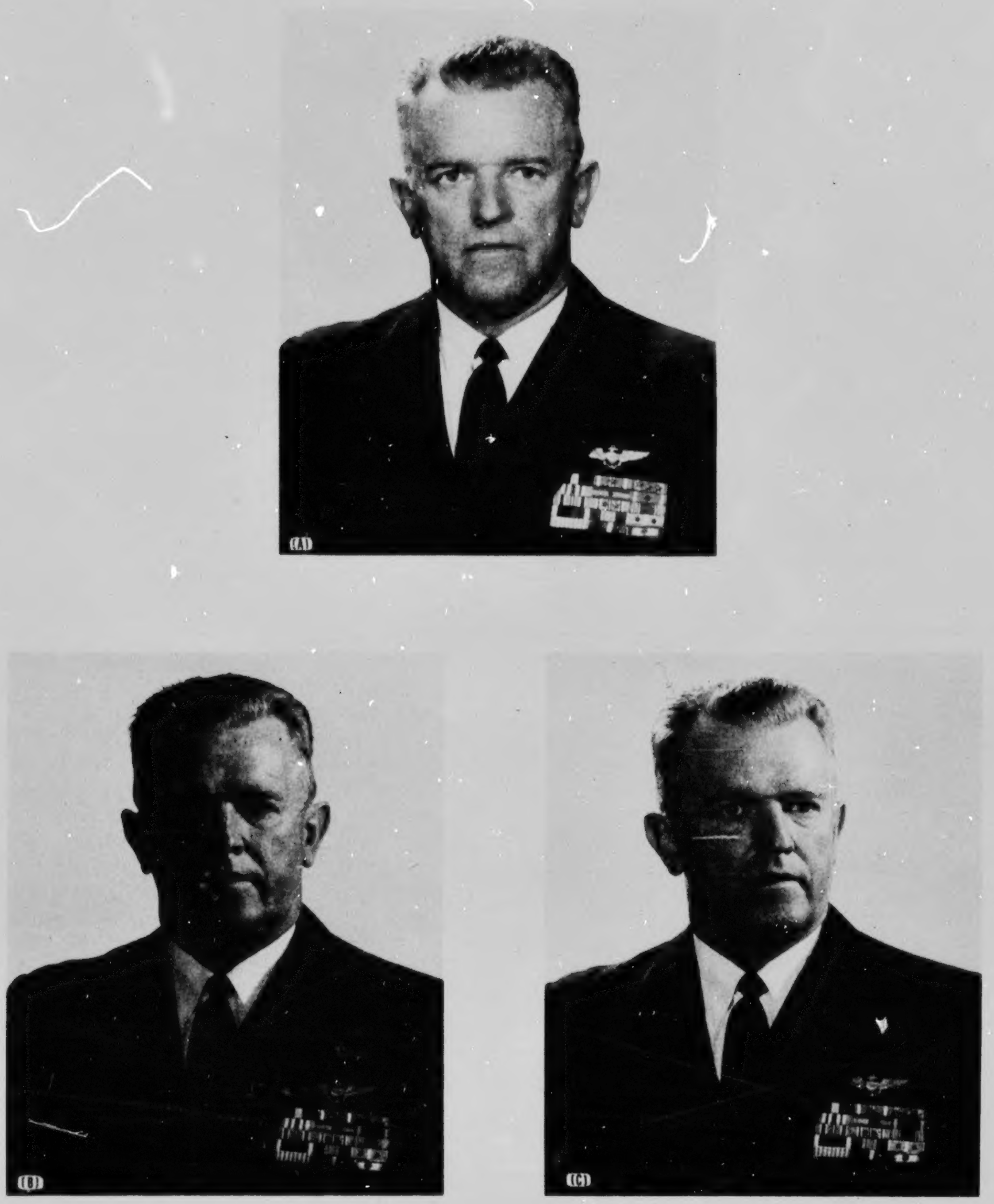


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Figure 4-3.—Changing positions of the light and the subject to broaden or slenderize the face. (A) Head-on, flat lighting; (B) head-on, side lighting; and (C) head and body turned, side lighting.

the lay of the shirt and coat will insure a neat, well-groomed appearance. Be sure that he is correctly dressed and that medals, ribbons, insignia of rank or rate, and other accessories are properly worn. These minor details are easily overlooked and may make it necessary to retake the picture.

When the subject is seated, one particularly important point to consider is the lay of the coat collar. The collar has a tendency to separate itself from the subject's neck and project therefrom, giving the impression of a hump. The coat should be pulled down to make the collar fit properly and make the line of the back appear as free from slouch or stoop as possible. If the picture includes only the head and shoulders, the drape of the coat can be improved by unbuttoning the lower button and pulling down on the bottom of the coat.

The sleeves are another problem, particularly when working with a seated figure. There is a tendency for the sleeves to work up and wrinkle at the elbow, leaving either a great expanse of wrist showing or an excessive length of shirt cuff. Have the subject pull the sleeves down and straighten out the wrinkles as much as possible. Wrinkles, folds, and creases in the uniform detract greatly from a neat appearance and are very difficult to retouch.

When legs are crossed in a full-figure portrait, the leg nearer the camera should be crossed over the other. In this manner, the knee and foot will not be pointed at the camera to present unpleasant distortion. One foot will appear unduly large and the bottom of the shoe may show in the picture if the far leg is crossed over the near leg.

In posing the subject, strive to obtain a feeling of motion in the picture. Composing the subject directly in the center of the view with head and shoulders squared to the camera will usually result in a most uninteresting, static appearance. By turning the shoulders slightly away from the camera, then turning the head back toward or past the camera, a feeling of motion can be obtained. Observe carefully that the head is not turned in a different direction to that of the shoulders to such an extent that it causes wrinkles of the neck. Some women can be posed with their shoulders parallel to the lens axis and their heads turned so as to face almost directly toward the camera; however, this pose rarely works well with men.

When turning the head in a different direction from the shoulders, there is a natural tendency to lean the neck forward and the head sideways. Leaning the neck out of alinement with the back makes it appear at an unnatural, awkward angle. Although the pose may actually be uncomfortable, be sure that the neck and back are in alinement and the head is held straight while taking the picture. The subject will then appear more alert and the picture much more pleasing; otherwise, it will appear that the subject is in a slumped, relaxed attitude.

Generally, the subject should be looking almost straight ahead, regardless of how much the head is turned away from the camera. If the eyes are turned very far to one side, an excessive amount of white will show at one side of the pupil.

The subject may be photographed from many angles; facing directly at the camera or his head turned away from the camera in either direction as much as a full profile. However, the head should not be turned to an angle that causes the bridge of the nose to cut across and hide a portion of the eye farthest from the camera. Neither should the nose cut across any part of the distant cheek line. If the distant ear is to be seen at all, turn the subject so that enough of the ear shows to recognize it as such. When only the tip of an ear shows, it may appear as a growth on the side of the head or face.

Special attention should be given to the position of the arms and hands (fig. 4-4), even though the hands do not show in the picture. The position of the upper arms can greatly influence the feeling of support and balance to the figure. The arm nearer the camera should be drawn back far enough to at least put it in line with the back and neck. The other arm should be extended forward slightly ahead of the body so that the upper arms are not parallel, ((B) of fig. 4-4). This somewhat triangular arrangement appears to lend support and balance to the figure. The hands can be comfortably placed one on top of the other in the lap close to the body. Do not permit the back or palm of an open hand to be held squarely to the camera if it is included in the view. To do so would make it appear large and distracting.

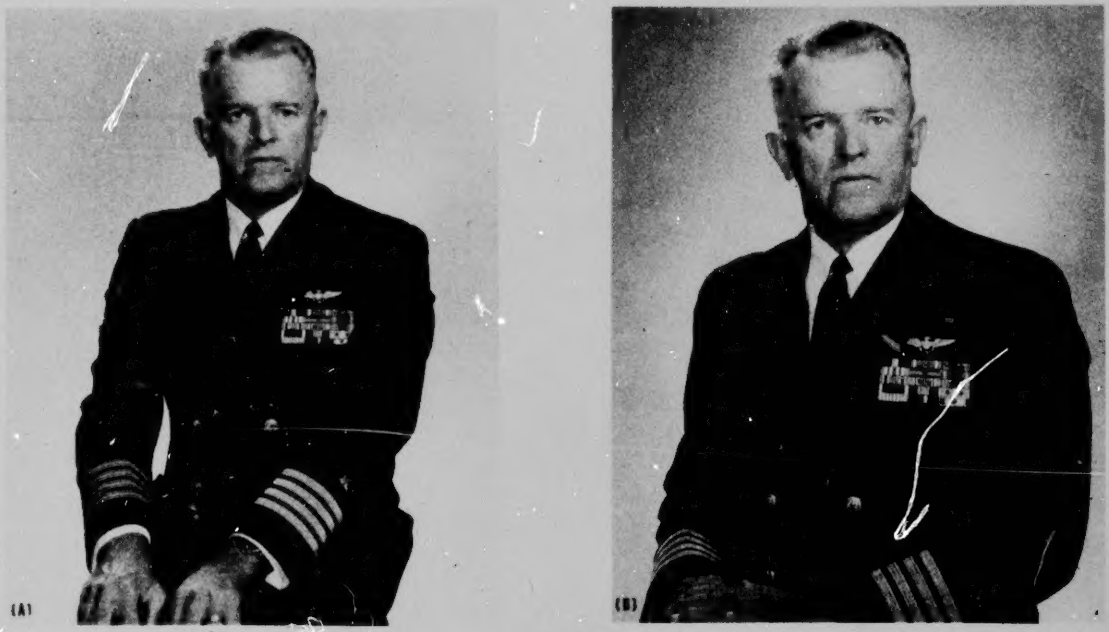

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Figure 4-4.—Position of arms adds balance to the portrait. (A) Arms in wrong position; (B) support added to figure by proper positioning of arms.

It is most difficult to compose the figure on the negative so perfectly that the composition cannot be improved by cropping. The actual placement of the figure for the most pleasing presentation is dependent to a great extent on lighting, camera angle, amount of figure included, and direction the subject is turned. All of these factors are combined to enhance the portrait and retain attention within the rectangle. For the most part, composition is a matter of likes and dislikes. If a picture appears attractive to you, it will very likely appeal to others. If you dislike a picture for some reason, chances are it will also be unattractive to others. Generally, more space should be allowed in front of the head than behind it, and the top of the head should be near the top of the picture. However, do not hesitate to break the basic compositional rules if doing so will definitely improve the picture.

ANGLE OF CAMERA

Normally, the camera is positioned so that the lens is about the same height as the subject's eyes. At this height, the most pleasing perspective will be obtained in a head-and-shoulder portrait of a person having an average, oval-shaped face. However, the camera can be raised as necessary to diminish the appearance of certain unusually long, angular faces and necks. A camera angle below eye level will tend to improve the appearance of a person with a short neck, long nose, or bald head, and from a low camera angle, much less of the top of the head can be seen. If the light is shielded to reduce the illumination on top of the head, baldness will be less noticeable.

A low camera angle is slightly more difficult to work with than a high one. It exposes the nostrils more prominently, making them appear as two black holes. Placing the modeling light high will cast a shadow beneath the nose so that the nostrils blend in with the shadow area. If a low camera angle has been selected to reduce the effect of a large, long nose, the subject should face almost directly toward the camera. His head should be held high or even tilted back slightly. Placing the modeling light high and nearly in front of the subject will produce a very light shading on one side of the nose emphasizing it to a lesser degree.

A high camera angle is effective for smoothing out a double chin. Have the subject lean forward and lift the chin slightly. Turning the head too far in relation to the shoulders may wrinkle the skin and give the appearance of a double chin. When this occurs, have the subject turn his shoulders more squarely to the camera.

If sufficient space is available, the distance between the camera and subject should be sufficient to permit easy passage between them. No difficulty will be encountered with distortion if the distance is sufficient to prevent the image size of the head from being greater than one-sixth of the focal length of the lens. Very rarely should the image of the head occupy more than one-third of the long dimension of the negative. If a larger head size is desired, the negative can be enlarged and cropped in printing.

COMPOSITION AND FOCUS

After the subject has been posed check the camera for composition and focus. Although this step should not consume much time, it must be done carefully and critically. Regardless of how good the pose, lighting, and expression may be, poor composition and an unsharp image will ruin the picture. Do not crowd the negative to such an extent that some cropping will be impossible in printing. The top of the head should be near the top of the negative, but allow a little room for cropping at the sides and bottom. Allow a little more space in front of the head when the subject is turned to one side. It is very difficult to compose the picture perfectly on the ground glass, particularly with the image inverted. There will be plenty of time for carefully balancing and cropping the negative for more perfect composition during printing. Pay particular attention to the position of the body as it is framed on the ground glass to see that it does not appear to be falling out of the picture. It should appear to support the head in a natural and comfortable manner.

See that the arms are positioned so as to lend support to the figure. The arm nearest the camera should be drawn backward while the other is pushed forward slightly to form a triangular-shaped base for the figure. Do not allow an arm or shoulder to droop out of the picture like a drain spout. Pushing either arm too far away from the body will allow the background to show between the arm and background. This is particularly objectionable if the background is of a contrasting color to the clothing.

The eyes are the most expressive elements of a person's features. They are the center of interest; attention being drawn to them first when viewing a portrait. It is imperative that they be in critically sharp focus, clear, and lifelike. If a bright reflecting catch light is allowed to show in each eye, it will enhance their sparkle and brilliance. Other portions of the figure may be slightly out of focus without appearing too distracting, but not the eyes. The subject need not always be made to look in the direction of the camera; neither should he be made to look directly into the lens.

The degree of unsharpness permissible in other portions of the figure is a matter of personal likes and dislikes. However, if insignia of rank or rate and ribbons or medals show in the picture, it is usually quite distracting when they are excessively out of focus. The adjustable swings on the back of the view camera can be used to good advantage in obtaining a greater depth of field and sharply focusing the entire figure. Check carefully, however, so as not to become so engrossed in focusing both eyes sharply that other parts of the figure are thrown out of focus. The sharpness of the image should be checked on the ground glass with the diaphragm set at the stop to be used for the exposure.

The shutter should be set for an exposure of not longer than one twenty fifth of a second if possible. Even though the subject is seated and a sturdy camera support is used, a portion of the image may be blurred from movement when longer exposures are made. The blurring usually occurs in some part of the face and may not be apparent until a print is made. Facial expressions can change very rapidly, perhaps as fast as the blinking of an eye. A slow shutter speed may be unable to catch a fleeting, momentary expression which would be more flattering to the individual.

Unless some method is employed to induce a pleasant expression, the subject will generally appear bored and uninteresting. Simply telling them to "look this way" or "smile" is not sufficient. After all, just what is there at this time to cause a person to smile and look pleasant? A forced smile sometimes looks more like a frown. When photographing small children, some photographers show them gaily colored toys or make funny faces to induce a good expression. With adults, however, a more subtle method is necessary.

The best method of obtaining a good expression is through conversation. Talk about anything which comes to your mind—a recent incident, a funny story, the weather, or any other topic which will tend to cause the subject to concentrate momentarily on something other than the business of making a portrait. A stiff, blank, and empty expression while staring into space certainly does not radiate much personality. With most people a smile is contagious. When you smile at a person, even though he does not have the slightest idea why, he will usually smile in return. The photographer can quite often employ this method to get the subject to smile. Beware of a broad smile, because it rarely looks attractive and is not too appropriate for a person in uniform.

While trying to find or induce the expression which will show off the subject to the best advantage, be particularly observant of the little details so necessary to a neat appearance and good composition. See that the head is tilted at the right angle and in good relationship to the shoulders to produce the most harmonious lines of the body. Smooth out any ugly wrinkling or bunching of clothing. Be alert to the slightest change in pose or expression because these changes often come and go in an instant. When the expression is at its best—the most natural and pleasing—shoot quickly before it changes.

Too much emphasis cannot be placed on the necessity for learning the mechanics of lighting and camera operation until they can be done almost automatically without hesitation or thought. Attention should be devoted entirely to the subject and not diverted to the technical phases of portraiture. Develop a definite sequence of operation. It will greatly increase your speed and self-confidence in being able to make good portraits.

PORTRAIT LIGHTING TECHNIQUE

The success of a portrait is dependent equally as much on lighting as posing. The manner in which the subject is lighted can actually set the mood of the portrait. Lighting which is soft and weak in contrast makes the subject appear quiet and restful and may lack interest.

When the light comes from the side or above the subject, the resulting shadows round out and enhance the facial features to induce exciting values of depth, alertness, and expressive vitality. Bad lighting can actually subdue and distort the features to such an extent that the identity of the subject becomes difficult. Good lighting shows off the subject to the best advantage, bringing out the form, roundness, and expressiveness of the features.

The best portrait lighting simulates conditions of sunlight. Much can be learned about lighting by simply observing people's faces under various lighting conditions. We are accustomed to seeing faces illuminated from above or the side, casting shadows downward and sideways. Light coming from below eye level is not normal. It will produce a ghastly effect which is very unnatural and displeasing with shadows being cast upward. Lighting which appears most pleasing and normal will produce prominent highlights on the forehead, nose, cheeks, and chin with sufficient shadows to round out the curvature of the features. When the shadows are deep, an auxiliary light is usually, though not always, required to fill them in for a more natural appearance. Shadows from the modeling light can be softened considerably by a diffusion screen and by moving the light farther from the subject.

The beginner commonly makes three mistakes on his first attempt at lighting for a portrait. The modeling light is often placed too close to the subject, the fill-in light is placed at about the same distance as the modeling light, and an attempt is made to use too many lights. When the modeling light is placed too close, the glare and heat are uncomfortable to the subject, dense shadows are formed, and the intensity of illunimation varies excessively from one side of the face to the other. Depending on the intensity of the modeling light, place it 4 to 6 feet from the subject and raise it above his eye level. If the fill-in light is placed about the same distance from the subject as the modeling light, shadows on the side of the face will be eliminated instead of subdued and crosslighting will result.

Crosslighting is recognized by two distinct nose shadows—one on each side of the nose—when the lights are at an angle of 30 to 40 degrees to the lens axis. With the lights farther to the side, the nose shadows will disappear, but a light shadow area will be formed down the portion of the subject's face nearest the camera. When the fill-in light is used, it is usually placed about at the subject's eye level near the camera and about 50 percent farther from the subject than the modeling light. Attempting to use too many lights will certainly confuse the beginner. Shadows will be cast in many directions and the resulting flat lighting will destroy all modeling effects. Two lights used correctly will illuminate the subject in a much more interesting manner than four lights used incorrectly.

The simplest lighting setup is often the best. Try to illuminate the subject with one light. Place the modeling light near the camera and at an elevation slightly higher than the subject's head. Move it to the side the subject is facing and change the elevation as necessary to obtain the desired effect.

A good lighting arrangement is to place the light about 45 degrees from the subject's line of vision and at a height to form a nose shadow beginning at the inside corner of the eye and extending downward toward a corner of the mouth. The light should not cast a shadow into the eye from either the nose or eyebrows. A triangular-shaped highlight should be formed on the cheek adjacent to the nose shadow and extend no lower than the base of the nose.

When it is necessary to use the fill-in light, place it on the opposite side of the camera at about eye level. It should be diffused and at such distance as to maintain a lighting ratio of approximately 1:3 with the modeling light. If a dark background is used, it is a good idea to add a back light or rim light to show separation between the head and background and add depth to the picture. When a light background is used for a high-key effect, use sufficient illumination on the background to keep it light. Such an arrangement of lights will usually be satisfactory for portraits of most individuals in the Navy. However, it is presented only as a guide and not a plan to solve all lighting problems. Certain irregularly shaped faces will require an entirely different arrangement of lights for the most flattering results.

The mood presented in a portrait can be greatly influenced by the predominating tones of black or white on the print. The key or tone of a picture is determined mainly by lighting, but is also influenced by the color of wearing apparel and the background. A high-key portrait has tones which are predominantly light, going from white to gray, but with very little black present. It is used to express softness and gentleness and to portray youth. The tones of a low-key portrait are predominantly dark, having very little white present. The excessive amount of black and gray lends a dramatic effect and is generally more appropriate for elderly people. In between these two extremes is the normal or medium-key portrait which contains a full range of tones of gray, being neither predominantly dark nor light. It is the most common type of all and is most appropriate for portraits of naval personnel. Make a study of the lighting used on various portraits; the angle it strikes the subject, the direction and length of the shadows, and how and where the highlights are formed. This is excellent training in learning to recognize good lighting when you see it on a person's face. Practice on a friend, trying to duplicate the lighting which appears best. Notice that moving the modeling light only a small amount can change the appearance of the face. The only real secret to lighting is learning to do it almost automatically so that attention is not diverted from the subject, and to recognize or "feel" when the lighting is correct rather than see it consciously.

Basic Portrait Lights

The single basic principle regarding any lighting technique is that there should be only one main or dominant light source. Any additional light(s) used must be secondary to the main (dominant) light source. Only one shadow cast, regardless of the number of lights used, should be viewed from the camera position, which would also indicate the postion of the viewer of the finished print. Any indication of more than one light source is somewhat distracting to the viewer even though this reaction may be entirely subconscious. The principle of having only one dominant light source apparent in the photograph applies to all aspects of photography. Five of the individual lights used most often will be covered in this section, although the number will vary, depending upon the number of lights available for use, the amount of room to place these lights, and the purpose of each light. Generally, there should be a definite reason for using each of the individual lights; indiscriminate use of a variety of lights without a definite purpose for each light can only result in a poorly lighted photograph that would only tend to confuse the viewer. The five most common individual lights with which we will be concerned are as follows:

1. The main or modeling light.
2. The fill-in light.
3. The background light.
4. The back light.
5. The hair light.

The purpose and normal positioning of each of these lights will be covered in this section. The photographer should not attempt to slavishly copy so-called standard lighting methods or be concerned with their placement as the final goal. What the photographer should do to save himself trouble is to learn the purpose for each individual light and the standard basic lighting techniques as references; then depart from them as the need dictates. He must learn to use lighting as an instrument to create a portrait as an artist uses his brush and paints or a writer creates with pen and paper. Each individual tries to express himself while also remembering that the prime goal is to satisfy the subject, who will generally have the last say in the matter.

THE MAIN OR MODELING LIGHT.–This light is used to model the face and create a three dimensional effect by either emphasizing or deemphasizing the depth and roundness of the various facial planes. The gradual transition of differing tonal values from one area of the face to the other, with its varying contrast between light and dark areas, creates a modeling or three dimensional effect. Those planes of the face which are lightened the most will be emphasized over those areas which are either in the shadows or have a darker tonal value.

Normally, the main light is placed 45 degrees to one side of the camera-to-subject axis, and higher than the subject's head, the exact distance depending upon the following factors:

1. Light output of the unit.
2. Subject area to be covered.
3. Lighting effect desired.

When taking portraits of personnel wearing caps with a bill, the main light will have to be lowered somewhat to reduce or eliminate the shadow often cast down into the face by the bill of the cap.

The recommended method to use in positioning the main light is to watch for catch lights in the eyes. Catch lights, depending upon the direction in which the subject is looking and type of lighting used, should appear in approximately the 1 o'clock or 11 o'clock position in the eyes when observed from the camera lens position. THERE MUST BE ONLY ONE CATCH LIGHT IN AN EYE. More than one catch light destroys the feeling of dominance of the main light source.

Diffusing the main light is recommended because the shadows are softened and retouching minimized. A diffused main light is used more often than one which is not diffused. An undiffused main light accentuates facial textures and character lines but is more difficult to control; therefore, it is used more for character studies and special effects for salon type photography. To more accurately observe the modeling effects of the main light in addition to the catch lights, observe the position and size of the triangular highlight on the face.

The correct location of both the catch lights and triangular highlight can be observed with accuracy only from the camera lens position. Proper positioning of the triangular highlight is covered in PH 3 & 2, NavPers 10355-A. The size of the triangular patch of light (high light) is determined by the width of the face being photographed. The narrower the face being photographed, the larger the visible highlight area; this results in a larger triangular patch of light than is needed with a normal sized face. A wider face requires, for maximum slimming effect, that more of it be kept in the shadow areas, resulting in a smaller patch. Moving the main light farther behind the subject will result in a smaller patch of light. Split or side lighting will result if the main light is moved so far behind the subject that no patch of light is formed. Split lighting is very rarely used. The occasions when it may be necessary to use split lighting will be covered in a later section of this chapter.

THE FILL-IN LIGHT.–After the main light has been positioned, the next light to be considered is the fill-in light. Fill-in lights were covered in PH 3 & 2, NavPers 10355-A, but additional information is provided in the following paragraphs.

Shadows are cast whenever a single light source is used. Outdoors these shadows are somewhat subdued or softened by reflecting surfaces that are located near the subject. Indoors there are normally no suitable reflectors to soften or lighten the shadows cast by the singular main light. The human eye has the ability to rapidly adjust itself to varying intensities or latitudes of light. It can see detail in the brightest highlight area of a subject, then without hesitation see detail in the deepest shadow. Photographic sensitized materials cannot adjust to these extremes of lighting contrast in the same manner and to the same degree as the human eye. Shadow areas in which detail is still visible to the human eye may fail to be recorded on the film. If shadows are recorded, they may appear in a more contrasty manner than they appeared to the eyes.

Fill-in light is used to provide the lighting ratio desired between the highlights and shadows of the portrait and to provide the shadow areas with necessary detail. The power and the distance of the fill-in light determine what this ratio will be. Normally, a 3 to 1 ratio is best suited for portraits. A lower ratio such as 1 to 1 eliminates the shadows and destroys the modeling which was created by the main light. A too high ratio does not provide the necessary amount of light to illuminate the shadows, causing them to go too dark and, if the ratio is too high, even completely unexposed. Lateral positioning of the fill-in light is often necessary to remove undesirable shadows caused by the so-called smile lines and to reduce the specular highlights caused by this light. The fill-in light is a necessity for color portraits. In areas of deep shadows no light is reflected back to the film, resulting in a lack of color in those areas.

BACKGROUND LIGHT.–The background light is customarily thought of as the means by which tonal separation of the subject and background is provided and objectionable shadows created by the main and/or fill-in light on the background are eliminated. Additionally, the mood of the portrait is somewhat dictated by the tone of the background. High-key portraits require that the background be illuminated more brightly than for a normal portrait, while low-key portraits require little if any background light. For normal portraits the background illumination should be less than that of the subject. In color portraits the proper illumination of the background is of great importance. If the background color is to be recorded as it appears to the eyes, it must receive the identical quantity of illumination as the subject's face. As the subject should be positioned 6 feet or more from the background (provided space permits), spill light cannot sufficiently illuminate the background. If the background color is to be recorded as seen by the eyes, it must be illuminated separately, with the same amount and type of illumination that falls on the subject's face. Obviously, if one is using a tungsten light source to illuminate the subject's face, he should not attempt to illuminate the background with an electronic flash unit. In other words, in color portraits do not mix light sources such as tungsten and electronic flash. If the available background color is either too dark or too light, it may be made to photograph in the shade or tone desired by varying the amount of light it receives. If a lighter shade is desired, increase the intensity of the background illumination. If a somewhat darker shade is desired, decrease the intensity of light on the background. By the use of colored gelatin filters over the background light, the background color can be changed. If a color filter is used over the background light, be sure that none of the light is spilled over onto the subject.

POSITIONING OF THE BACKGROUND LIGHT.–The background light must not show in the picture. Its exact distance from the background will depend upon the intensity of background illumination desired. A simple method is to place the light behind and directed toward the subject so that the shadow cast by the subject will completely cover the camera. When the light is positioned so that the subject's shadow completely covers the camera, the background light will not be visible to the camera lens. After this adjustment has been made, turn the light 180 degrees so that it is directed toward the background.

DETERMINING LIGHT RATIOS.–The correct lighting ratio between the main and fill-in lights, and the correct lighting ratio between the main, fill-in, and background lights can be readily established by the use of a reflected light meter and a gray card or an incident type light meter. If an electronic flash is utilized, then an electronic flash exposure meter can be used to determine the correct lighting ratios. For a basic discussion of lighting ratios refer to Chapter 14 of the PH3 and 2 Rate Training Manual, NavPers 10355-A.

THE BACK LIGHT.–The back light is generally a spotlight; it is usually positioned on the same side as the main light, at a height slightly above the level of the subject's head and behind him. The back light is a very effective means of providing additional separation between the subject and the background. Somewhat silhouetting the back of the head and shoulders, it is particularly useful in separating dark clothing from a dark background. Adding this light to the regular lighting setup will form bright, accenting highlights in the hair and on the shoulders. The back light, if used properly, helps to add detail to the hair (better to use too little light than too much). The back light should be placed on the same side of the subject-to-camera axis as the main light. The back light, when positioned in such a manner that it rims or grazes the extreme edge of the face, adds a feeling of strength to the male face. The photographer must be careful when using the back light in such a manner, so that the light does not spill over into the face to such an extent that the effect of the modeling light is ruined. The back light must not be allowed to illuminate the tip of the subject's nose, or if positioned on the side opposite from the main light, it must not outline the ear so that it appears to be separate from the head. The illumination of the back light must also be screened in some manner (barn doors, head screens) to prevent spill light from shining into the camera lens. NOTE: If any illumination is allowed to spill over into the camera lens from any of the lights, lens flare will reduce the image contrast.

THE HAIR LIGHT.–Adds detail to the hair, and provides another means of subject-background separation. The hair light is generally a small spotlight used on a boom. To be used effectively it is usually placed in one of three positions relative to the subject. These positions are directly above the subject's head; to either the right or left side of his hair or above and to one side of the subject's head.

The hair light should not be allowed to spill over into the face; this may cause small, distracting highlights and belie the basic principle of portraiture–namely the visual appearance on the photograph of a single light source. The hair light must be used with caution, if used at all, when the subject is wearing a hat. Additional, and distracting shadows may be cast down into the subject's face from the brim or bill of the hat.

The color and sheen of the subject's hair can be improved by the use of a hair light. The amount of illumination allowed to fall on the subject's hair is dependent upon the photographer's and subject's personal preference with the following considerations:

1. Darker colored hair requires more illumination than lighter colored hair.
2. Dull hair of any color requires a relatively extensive amount of illumination to give the effect of sparkle and life to the hair.

As with the background and other individual lights, no light must be allowed to spill over into the camera lens. When determining the exposure through the use of an exposure meter, both the back light and hair light must be turned off. These lights may incorrectly influence the meter while having no effect on the basic exposure.

Basic Portrait Lighting Techniques

The three basic lighting techniques used in portrait photography are as follows:

1. Broad.
2. Short (narrow).

3. Butterfly.

Each type will be covered in this section.

BROAD LIGHTING.—When broad lighting is used, that side of the face closest to the camera-lens position is fully eliminated. With broad lighting little or no modeling is provided to emphasize the contours of the face, deemphasizing the facial textures. The illusion of depth is also diminished when broad lighting is used. Though short (narrow) lighting will properly be used more than any of the other types, there are two situations in which broad lighting is required. The first is to visually widen faces which would appear too thin or narrow by other lighting methods. The second is to provide more illumination of the face in color photography.

The standard procedure for setting up broad lighting is as follows:

1. Establish the best location for the main light source, checking the following three points in particular:

a. The side of the face nearest the camera is fully illuminated, while the far cheek is illuminated with a triangular shaped highlight.

b. The nose shadow should be at a 45 degree angle down and toward the far corner of the mouth.

c. A single catch light should be present in each eye.

2. The fill light should be placed in position. Careful consideration must be given to proper placement of the fill light, so that the desired ratio of illumination (normally 3 to 1) between the main light and fill light is maintained. To avoid the creation of secondary shadows, the fill light is generally placed on the opposite side of the lens from the main light, at the same height as the camera lens and diffused.

3. The background light should be placed in position as previously discussed.

4. The hair light, if used, should finally be placed as described earlier in this chapter.

SHORT (NARROW) LIGHTING.—Short lighting is normally used for the average type face. As opposed to broad lighting, the side of the face farthest from the camera lens is fully illuminated when short lighting is used. Short lighting is ideal for strong, masculine and/or low-key portraits when used with a comparatively weak fill light.

The standard procedure for setting up short lighting is as follows:

1. Establish the best location to place the main light. The main light is positioned in such a manner that the side of the face farthest from the camera lens is fully illuminated. The previously mentioned triangular shaped highlight is formed on that side of the face nearest the camera lens, and only a single catch light is present in each eye. If the ratio of illumination between the main and fill lights is increased by illuminating only that side of the face farthest from the camera lens, while allowing the side nearest the camera lens to remain in shadow, "split lighting" occurs. Split lighting is a very effective corrective lighting technique to use in visually narrowing faces which appear too broad.

2. Position the fill light on the opposite side of the camera lens from the main light, and at camera lens height. The distance at which to place the fill light from the subject is dependent upon the desired lighting ratio, with a 3:1 ratio normally preferred.

3. Position the background light so that the subject will be facing toward the side of the background having the lightest tone.

4. Position the hair light, as described previously.

BUTTERFLY LIGHTING.—Butterfly lighting, while considered a glamour lighting for young women, is not suggested for portraits of men. This is due to the ears being made objectionably conspicuous by being highlighted. If the butterfly lighting is used on a female subject, then the following standard procedure is recommended:

1. Position the main light so that it is directly in front of the face, at a height above the face which will allow the nose shadow to be cast beneath and in line with the nose. The nose shadow should not reach the mouth. There is no triangular shaped patch of light formed on either side of the face, and both sides of the face are equally illuminated with butterfly lighting.

2. A fill light is not required, though a weak fill light in relation to the main light can be used in lighting the shadows cast on the subject's neck by the main light.

3. The background and/or hair lights may then be placed as mentioned earlier in this chapter.

CORRECTIVE METHODS

The main objective of the portrait photographer is to produce a portrait of the subject which will represent him in the most favorable manner. To improve upon the subject's appearance, corrective techniques in posing, lighting, and camera angles should be used whenever possible. Table 4-1 lists the more common problems encountered by the portrait photographer, with recommended techniques for correction.

PRINTING TECHNIQUE

Regardless of the effort and attention given to composition while taking a portrait, its effectiveness can usually be improved by cropping when making the print, as illustrated in figure 4-5. Part (A) is a straight print from the negative, and includes too much of the body. Part (B) is a slight enlargement and is much more pleasing to the eye. If just a head shot is needed, the same negative can be used, as shown in part (C). Better balance can usually be obtained by enlarging the image sufficiently to crop out undesirable areas and provide better directional spacing of the head within the rectangle. Turning the easel to rotate the image can work wonders in improving the composition.

Unsightly shadows on the background can sometimes be eliminated. The shoulder line can be righted somewhat so that it will appear to give a better foundation for the head. Enlarging and rotating the image may eliminate the effect of an arm dangling out of the picture or a drooped shoulder. Move the image around on the easel, rotate and enlarge it until the composition is most effective and pleasing. There are no specific rules to follow—just good common sense—in spacing and balancing the image on the print. Usually the top of the head is positioned near the top of the picture and more space is allowed in front of the face than behind the head.

There are times, due to faulty posing, when no amount of enlarging, rotating, and cropping of the negative will give the proper feeling of balance to a portrait. One possible method of saving such a picture is to "burn in" and darken an area along the side or bottom of the picture so that a feeling of balance is achieved by contrasting tones or shades of gray. Some photographers make a practice of darkening the bottom of a portrait slightly, either by manipulating the lighting so it will be less intense on the subject in that area or by burning in the bottom of the print. This is most effective when the foundation appears too weak to support the head properly. It is a common practice to darken the corners of a portrait in printing in order to confine attention within the rectangle and place more emphasis on the subject. Darkening of the bottom and corners should be graduated, decreasing in intensity toward the center of the picture. It should not be so intense that it produces a solid black at the borders of the picture.

Printing is one of the most important steps in portraiture. The best job of posing, lighting, and composing can become mediocre through carelessness in printing. It is neither difficult nor so involved that it requires any special training—just a matter of using the senses to determine when something is wrong with a picture and what to do to make it right. If it appears pleasing to you in every detail, chances are very good that the subject will also prize it highly. From analyzing the subject to making the print, no detail is too minor to be neglected as unimportant. Anyone can learn to be technically competent in all the phases of portraiture. In fact, it is essential to become so proficient in each operation that it can be done almost subconsciously. It requires much more than technical ability to produce good portraits. If one is absorbed in technique, he will be unable to attend to the many minor details which are of really major importance in portraiture.

TECHNIQUES OF SPOTTING

The ideal situation in the photographic process is to produce negatives with a tonal range corresponding to areas in the original subject and to produce negatives and prints free from spots and blemishes. When negatives and prints are not up to par we have to revert to

Table 4-1.–Corrective techniques.

Problem	Correction
1. Reflection from eyeglasses.	Adjust fill light to the side. Tilt glasses down by lifting ear pieces slightly. Slightly lift or lower chin. Use only frames without glass (it is recommended that the lab have on hand several pairs of frames of various styles and sizes for this purpose.)
2. Wide or round face.	Use short (narrow) lighting. Photograph three-quarter view of face. Photograph with camera angle above subject's eye level.
3. Thin face.	Photograph full front view of face. Use broad lighting. Adjust height of main light to eye level of subject.
4. Heavy-set subject.	Use short (narrow) lighting. Use dark uniform. Let subject's uniform blend with background tone. Use low-key lighting.

Table 4-1.–Corrective techniques–Continued.

Problem	Correction
5. Long nose.	Have subject look directly toward lens. Photograph with camera angle below subject's eye level. Place main light at a low height. Lift chin upward.
6. Bent nose.	Photograph with face turned toward camera.
7. Broad nose.	Photograph three-quarter view of face. Use narrow lighting to put near side of nose in shadow.
8. Facial defects.	If defects only on one side of face, keep that side in shadows. If defects on both sides of face, use diffusion screens over both the main and fill light. If permissible use a soft lens. Diffuse when printing negative. Keep main light low.
9. Large ears.	Use narrow lighting and take three-quarter view of subject, to hide far ear behind head and keep near ear in shadow.

Table 4-1.–Corrective techniques–Continued.

Problem	Correction
10. Bald or thinning hair.	Do not use hair light. Use a low camera angle. Use head screen between main light and subject to create shadow on top of head. Adjust background light so that top of head merges with tone of background.
11. Thin chin.	Lift chin upward.
12. Double chin.	Lift chin upward. Keep main light high. Use a high camera angle.
13. Deep-set eyes.	Keep main light low. Use lighting ratio lower than three to one.
14. Protruding eyes.	Subject should look downward.
15. Long, thin neck.	Use a high camera angle.
16. Short, thick neck.	Use a low camera angle.

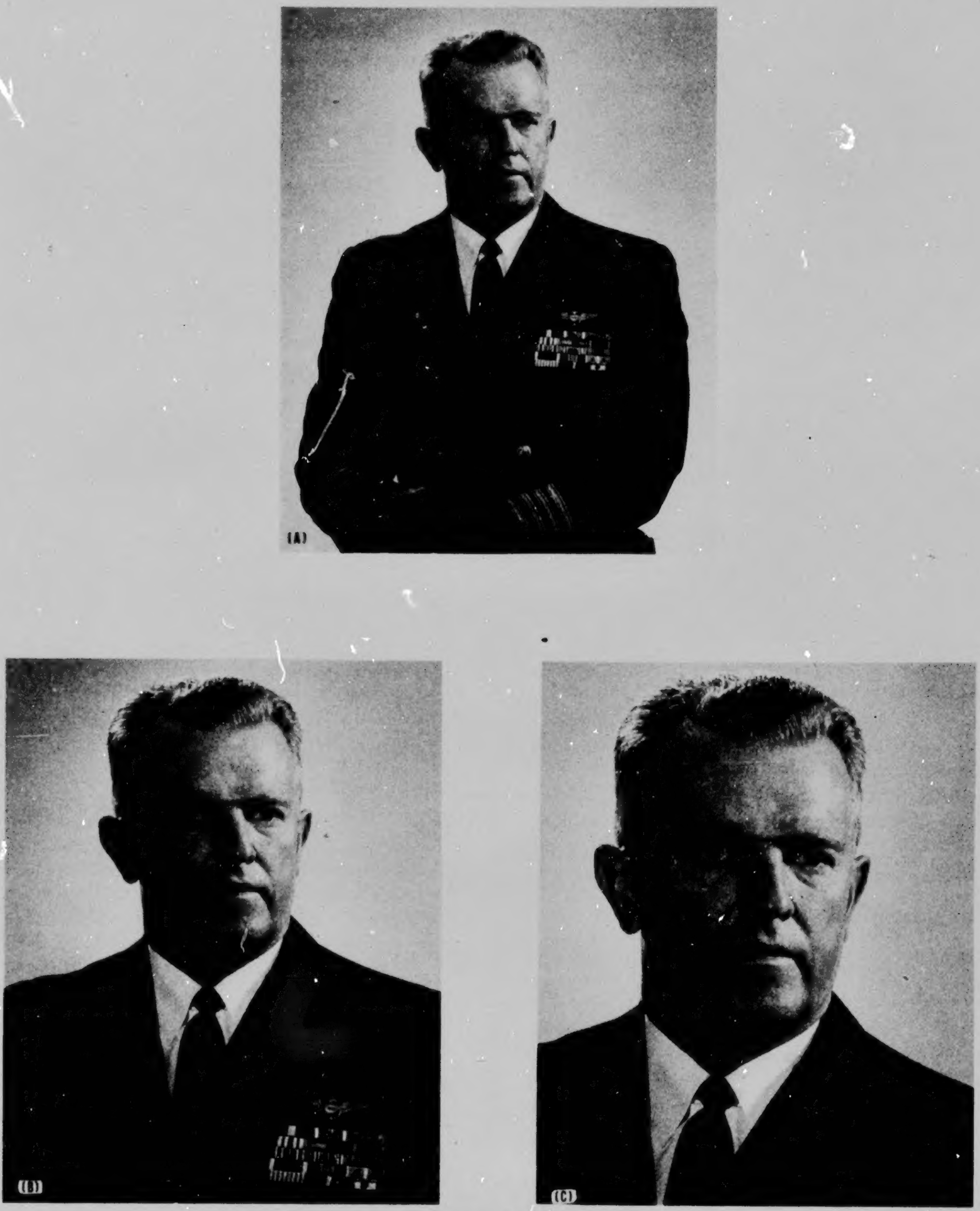

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Figure 4-5.—Changing effect of a portrait by cropping. (A) Three-quarter portrait; (B) head-and-shoulder portrait; (C) head portrait.

corrective treatment. The only way to produce perfect negatives and prints is to expose and process them properly. However, because at one time or another exposing or processing mistakes are made that cannot be rectified by making another negative or print, the Photographer's Mate should become familiar with the different methods of improving the negatives and prints which are not up to par.

NEGATIVE SPOTTING

Ordinarily, spotting refers to the practice of eliminating "pinholes" in the emulsion. If these pinholes were not removed, they would appear as black blotches in a projection print or enlargement. However, the term spotting also includes the elimination of dust marks, lint, small hairs, and scratches, which–in spite of the best care–often appear in negatives.

The materials used for spotting negatives are as follows:

1. Mapping pen–a very fine penpoint in a holder.
2. Fine pointed artist's sable brush (No. 00 or No. 1).
3. Webster's 1A red dye.
4. Opaque, spotting colors, or any light-resistant compound.

For spotting pinholes, the mapping pen and Webster 1A red dye are very satisfactory. Since the penpoint is very sharp, it has a tendency to pick up minute pieces of gelatin from the film: but with proper care in keeping the point clean, excellent work can be quickly accomplished.

For those who prefer using a fine-pointed brush with the opaque materials, the work of spotting is more difficult, due to the flexibility of the brush. Another objection to the brush is that the opaque on the fine point often dries between the time the brush is dipped in the material and the time it is applied to the negative.

Place the negative on a well-illuminated surface, emulsion down. A printer or plotting table may be used. Use the magnifying glass. Dip the mapping penpoint in the dye and lightly touch the spot on the BACK of the negative. If this operation is carefully performed, the dye can be confined to the spot without spreading over the surrounding area. The same technique is used with a brush and the opaque material.

If the pinhole is spotted with the dye on the emulsion side of the negative, the dye will be drawn by capillary attraction toward the edges of the hole, leaving the pinhole still uncovered. Scratches and dust marks are treated in the same manner.

The objective in spotting is to make the area that is spotted light resistant; thus, instead of appearing as a black mark on the print, the spot is white. Then the spot is subsequently eliminated in the print by a technique explained later in this chapter. If the pinhole was not spotted, and a black mark left on the print, it would have to be removed by etching, which is a great deal harder to do than print spotting.

PRINT SPOTTING

Prints are spotted to eliminate white or gray marks caused by dust, lint, and other similar particles which may adhere to the negative. Spots may also be caused by minute defects in the emulsion. In the prints such markings range in tone from white to dark gray; the technique of removing them varies accordingly. All print surfaces from ferrotype glossy to dull matte may be spotted. If spotting requirements are known before printing and the print requirement permit, it would be advisable to make matte prints since they are easier to spot.

Spotting is also practiced for the purpose of correcting or toning down certain areas, such as highlights, which appear too bright in a print, and which would be difficult to remove from the negative by etching. For small areas this toning down can be done with a spotting pencil, but for larger areas the use of the stippling brush is recommended.

A very useful dye used in print spotting is Spotone which comes in a variety of colors such as blue black, olive black, neutral base black, selenium brown, brown, and sepia. Spotone usually comes in sets of three colors with complete instructions for mixing and using. They may be used straight, diluted or mixed to match the hue of the paper. A good point to remember about dyes is that they sink into the emulsion rather than remain on the surface. A fine sable brush is required, the size depending upon the type of spotting to be done. Keep your brush just moist enough to let the dye penetrate. You should check your brush on an old print or along the border; this will remove the excess dye and give you a matching tone. Some prints will take dye more readily if the spot is prewet and blotted. If you apply too much moisture a blister will form, in which case it is best to re-wet the entire print and dry. Spotone, dries a little darker and warmer than when wet so wait until the spotted print is dry before matching tone. The objective of successful print spotting is to leave no indication of spotting.

OPAQUING NEGATIVES

The term "to opaque" means to eliminate some part of a negative image, such as an objectionable background, by covering the undesirable portion with a light-resistant dye or opaque compound. When such a procedure is used, the blocked out portion appears white in the print.

In addition to the materials listed for spotting, the following are required:

1. One roll of absorbent cotton.
2. Wooden sticks or skewers, drawn to a long taper with the points blunted.
3. One sable artist's brush, No. 6 or larger.

THE TECHNIQUE OF OPAQUING

Place the negative on a well-illuminated surface, such as a printer or plotting table. It is generally advisable to opaque on the back of the negative to avoid possible scratching of the emulsion. However, if proper care is used, the negative may be opaqued on the emulsion side or both sides if necessary.

Making a Cotton Stump

Pull a small tuft of cotton from the roll and draw it out as thinly and evenly as possible until it is about the size of a silver dollar. Then dip the pointed end of the stick or skewer in water. For right-hand operation, place the cotton on the index and second finger of the left hand. Lay the wet end of the stick on the cotton so that the point is about one-fourth inch from the edge of the cotton and the stick is about centered. The point of the stick should touch the ball of the index finger and not be beyond it, otherwise it will not be possible to wind the cotton securely over the point in the next operation. With the thumb, fold one side of the cotton over the stick. Then grip the cotton and stick tightly between the thumb and fingers and twist the stick, at the same time pushing it upward or outward until the cotton is completely and tightly wound over the point and around the stick. Moisten the fingers and wind the loose ends at the base of the cotton around the stick. This device is called a COTTON STUMP. (See fig. 4-6.)

Application of the Dye

Dip the cotton stump to about half its length in the Webster 1A red dye. Apply the wet dye stump to the outline of the image, using short, side-to-side strokes. Allow sufficient time for the gelatin to become saturated with the dye. With a little practice, it is comparatively easy to follow the outline accurately. The stump is rigid and is used in the same manner as a pencil.

If the background to be blocked out is very thin with practically no silver deposit and the

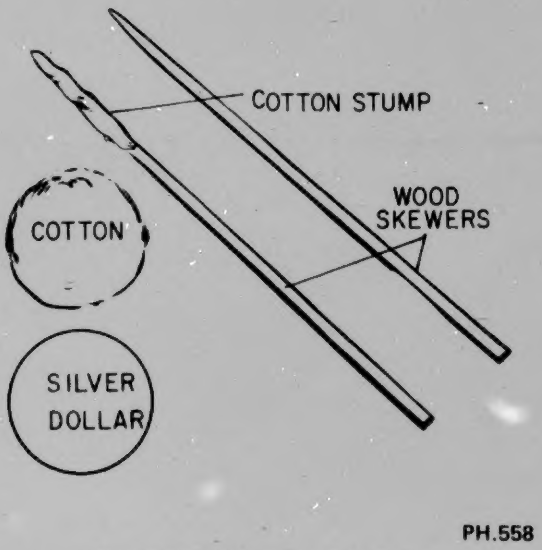

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Figure 4-6.—Making a cotton stump.

image is quite dense and requires a long exposure (a very contrasty negative), it may be necessary to block out on both sides of the negative to prevent the light from breaking through the dye during the long exposure.

Areas and angles which may be too narrow for the dye stump can be filled in by using the mapping pen. In fact, some operators prefer to use the pen for outlining work. After completing the outline, the remainder of the negative is quickly blocked by the use of the large brush saturated with the dye. Dye blocking will not crack or flake off the negative—once it is applied, it is permanent.

Application of Opaque

Opaque materials are composed basically of a type of dry pigment which is diluted with water for use. Blocking with opaque is accomplished by application of the wet opaque to the negative with a brush. The brush may be small or large, but it must be of the best quality of artist's sable in order that it may be drawn to a fine point when wet. It is more difficult to follow an outline accurately by this means because of the flexibility of the brush.

Errors are equally difficult to correct because the opaque has a tendency to smear, requiring further applications of a wet cotton stump to remove the smear. For this reason some operators prefer to first outline the image with a soft lead pencil, waterproof ink, or the 1A dye, and then block up to the line with the opaque. This all adds to the operating time in using opaque.

Correction of Errors

Errors in opaquing with the dye may be corrected by removing all or part of the dye. To remove only a slight amount of the dye, rub lightly with a cotton stump dipped in clean water. To remove more or all of the dye, use a 10-percent solution of sodium sulfite instead of water.

When applying the dye or using any liquid to remove the dye from the emulsion side of the negative, a light touch is essential; otherwise the emulsion may be rubbed off the film base. If a heavy deposit of dye is to be removed, the best practice is to soak the negative in a 10-percent solution of sodium sulfite with a moderate agitation until the red color and the resulting yellow stain both disappear. After this treatment is completed, wash the negative in running water for at least 5 minutes before drying. The negative will then be free from all traces of the dye and the work may be started again.

CHAPTER 5

COLOR PHOTOGRAPHY

PRINCIPLE OF COLOR PHOTOGRAPHY

All methods of color photography in use at the present time are three-color methods, recording proportionate amounts of three spectral bands present in the original object photographed. No three-color process can give absolute color fidelity; however, excellent reproduction of most colors appearing in nature can be had with a minimum of difficulty.

Three-color photography (like black-and-white photography) is concerned primarily with the action of light reflected from the subject through the camera lens to the sensitized material. One additional property of light governs the process. It is a fact that white light is known to be a mixture of light of various colors, due to the different frequencies at which its composing waves vibrate. In the study of light it has been found that presumably the speed of light is constant. It is known that these different frequencies imply different wavelengths of each different color. These wavelengths vary from 400 millimicrons at the blue end of the spectrum to 700 millimicrons at the red end.

Light that passes through a prism is broken down into a typical color band containing all the colors of which it is composed. In three-color photography, the spectrum is divided into three equal parts; red, green, and blue. These colors were chosen as the basis of color photography because they correspond to the sensitivities of the human eye. By combining red, green, and blue in varying amounts or intensities, almost any color can be reproduced and differentiated. The exception is that no differentiation can be made between two colors different in visual appearance but lying in the same spectral band. However, in all but the most technical of instances, the quality of reproduction is more than sufficient for our needs. The separation or division of the spectrum into three equal parts is accomplished by one of the following two means:

1. The use of filters, each transmitting the portion of the spectrum desired and absorbing the remainder of the spectrum.
2. Making each of the three recording emulsions sensitive to only one section of the spectrum.

The importance of this color separation can be seen when you consider the fact that none of our color processes actually record the image in color originally. The image is recorded as a normal black and white image in the camera and the color is induced later, usually during development. It is not only possible but highly probably that objects of totally different colors would record as the same density in these black and white emulsions. If the colors were not separated and recorded in different places, it would be impossible to dye the images their different colors during development.

The majority of the three-color processes currently used arrive at a color image in a different manner. Two of these methods, the additive color process and the subtractive color process, are discussed at length in chapter 17 of Photographer's Mate 3 & 2, NavPers 10355-A.

Some of the various methods of producing three-color images and printing them are discussed in this chapter.

METHODS OF TAKING COLOR PHOTOGRAPHS

In the years following WW II color photography came of age. From the realm of experimental procedure by the professional color specialist, color photography has grown to the stage where it is universally applied by the amateur and professional alike. With the modern materials and processes available today, fine color photographs may be produced by the beginner with moderately priced equipment.

Many processes have fallen into obsolescence since the advent of color photography, but on the other hand, improved methods are rapidly being introduced into the color field. At the present time the principal methods of taking color pictures are as follows:

1. Three separate films, separately exposed through filters to produce the necessary color separation negatives. Color separation negatives are used in the Kodak dye transfer process and in photomechanical trades.

2. Three emulsion layers coated on a single film base (integral tripack), producing either color positive transparency or a complement colored negative from which prints are made on a similar material, either paper or film. Most current processes belong to this class which has the following two subdivisions:

   a. Processes in which the three images are selectively color developed to produce the correct dye in each layer. Kodachrome belongs to this class.

   b. Processes in which color forming chemicals, called dye couplers, are incorporated in each layer. These dye couplers react with oxidation products of the developing agent to form the correct dyestuff in its layer. Anscochrome, Ektachrome, Ektacolor, and Kodacolor belong to this class.

Method 2b only is discussed in this chapter.

METHODS OF MAKING COLOR PRINTS

The principal methods of making prints from color separation negatives, color transparencies, or complementary color negatives are:

1. Toning methods, using either conventional or special toners on various types of stripping films or papers; the three toned images being stripped from their paper bases and reassembled on a single sheet, in register, to form a final print. This process is not in wide use.

2. Imbibition methods, causing three gelatin relief images to absorb colored dyes, which are then successively transferred to mordanted paper to form a three-color image. The Kodak Dye Transfer Process is one of this type.

3. Pigment methods, in which images are formed in pigmented gelatin and transferred to a final paper support in register. The Carbro Process once used by the Navy is an example of this type.

4. Three emulsions, coated on a single sheet of paper or film producing either direct positive prints from color transparencies or positive color prints from complementary color negatives. The print materials used for making color prints from POSITIVE color transparencies are Anscochrome Printon and Kodak Ektachrome paper. These materials are constructed with three emulsion layers and utilize reversal processing. Anscochrome Printon has a white pigmented cellulose ester base while Kodak Ektachrome paper has an RC (resin-coat) paper base. The print material which is described in this chapter for making color prints from negative films is the Kodak Ektacolor Professional Paper.

NEGATIVE COLOR FILMS

Negative color films are a part of a negative-positive color process which allows pictures to be produced in a variety of ways. Prints can be made on Kodak Ektacolor Professional Paper, Anscocolor Paper, or by the Kodak Dye Transfer Process, and by photomechanical methods. If black-and-white prints are required, color negatives may be printed on papers such as Scanaprint (GAF), or Panalure (Kodak). These papers work especially well for this purpose.

There are a number of manufacturers of negative color film; however, at the present time, the most widely used in the Navy is the Eastman Kodak process. GAF has come out with a negative type film, but as yet it has not had widespread use in the Navy.

Eastman Kodak Ektacolor, Type S; Ektacolor, Type L; Ektacolor Internegative, and Kodacolor film are constructed, basically, the same as reversal film. The color-coupler dyes used in the three-layer emulsion are the same color and perform the same function as those used in Kodak Ektachrome Film. The unused couplers remaining in the negative after development give the negative an overall orange cast and provide automatic masking for color correction. After processing, the dye images which remain are negative with respect to the tone graduations of the subject and are complementary to the colors of the original subject.

EXPOSURE

When exposing Kodak Ektacolor Film, avoid using light sources having different color qualities, or mixing tungsten and daylight. Make certain that unevenly polished or discolored reflectors are not used.

As an aid to determining exposures to be used when making prints from Ektacolor negatives, it is recommended that a gray card having a reflectance of 18 percent be placed in the photograph with the subject. An attempt should be made to place the gray card in the picture in such a way that it will have full subject lighting, yet can be cropped out of the final picture. If this is not possible, it is recommended that the card be photographed with full subject lighting on a separate sheet of film, which should be developed at the same time as the negative of the subject.

Kodak Ektacolor Professional Film, Type S is an improved type negative color film. This film is available in sheets ranging in size from 2 1/4 x 3 1/4 through 11 x 14 inches, in 120 and 35mm rollfilm sizes, and is designed for making color negatives at exposure times of one-tenth second or shorter. With exposure time one-tenth second or longer, use Kodak Ektacolor Professional Film, Type L.

Ektacolor Type S is balanced for exposure, WITHOUT a filter, by electronic flash, blue flash, or daylight. It has an Exposure Index of 100 for daylight.

The use of photoflood or 3200 K lamps with professional Type S is not recommended unless sufficient light can be obtained to permit an exposure of one-tenth of a second or shorter. The exposure index is 32 with photoflood lamps and a Kodak Wratten No. 80B filter, and 25 with 3200 K lamps and a Wratten 80A.

Ektacolor Type L Film is a sheet film designed for making color negatives that require exposures ranging from one-tenth second to 60 seconds with 3200 K lamps or with appropriate filters, by photoflood or daylight illumination. When using 3200 K lamps, no filter is required; however, photofloods require an 81A filter, with an exposure of 1 second, the effective exposure index is 64. Used in daylight, Type L requires an 85 Wratten filter; and with an exposure of 1/10 second, the effective exposure index is 64. The effective exposure index depends on the illumination level and the exposure duration. The data sheet accompanying the film contains a table listing the effective film speeds at various exposure times. As the exposure time increases, the slower the emulsion responds. For example, with a subject illuminated by 3200 K lamps, Type L has an effective speed of 100 with an exposure time of 1/10 second; at 60 seconds the effective speed is 32. Best results with type L film and 3200 K lamps are obtained by using an ASA of 64 and adjusting the intensity of the lights, their distance from the subject, and aperture of the camera for a 5 second exposure.

Type L is designed to give color the same potentialities and flexibility as black-and-white films, and is somewhat similar to the Type S film already discussed. However, the difference is that the Type L will allow the photographer to work with longer exposures and use lower light levels than have been possible with other color films of its type. Type L is generally used for interiors.

For a complete listing of exposure indexes, filters, exposure times, and light sources, refer to the Photo-Lab-Index, Section 16, Color Data, and the data sheet supplied with the film.

KODACOLOR-X

Kodacolor-X is a negative color film, intended for use with daylight or blue flashbulb illumination. This film is balanced for 3800° K illuminations, but photofinishers compensate for daylight or blue-flash exposures in their automatic printers.

When film is exposed as recommended in Kodacolor-X film instruction sheets, do-it-yourself printers or professional color laboratories frequently require the use of cyan or blue filters in the filter pack.

Kodak Ektacolor proessional film fulfills the needs of professional photographers in most situations. Should Ektacolor professional film not be available in a particular size, Kodacolor-X

Table 5-1.—Sources, filters, and ASA for Kodacolor-X Film.

LIGHT SOURCE	WRATTEN FILTER	ASA
Daylight	85C	64
Electronic flash	No. 85	50
3,400 K photo lamp	None	80
3,200 K tungsten lamp	None	80
AG1 or M3 clear flash bulbs	None	80
All other clear flash bulbs	None	80
Blue flash bulbs	No. 85C	64

can be used. If the film is exposed according to the recommendation given in Table 5-1, the negatives will have printing characteristics similar to Ektacolor negatives, usually requiring only magenta and yellow filters in the filter pack.

NOTE: Kodacolor negatives exposed in this manner are not intended for printing by photofinishing laboratories. If they are sent to a photofinishing laboratory, care should be taken to specify that the film should be printed in the same manner as Ektacolor Film.

Various manufacturers of electronic flash units now add a yellow or gold colored filter or coating to their electronic flash units, reducing the need for warming color conversion filters over the camera lens.

Kodacolor-X is an extremely fine grained film with which 30 x 40 enlargements can be made from 2 1/4 x 2 3/4 negatives quite routinely. Furthermore, the exposure latitude is greater than is possible with either Ektacolor S or Ektacolor L. Kodacolor-X is at present the only color negative film available in roll film for making exposures under low level illumination. Ektacolor S must be exposed for 1/10 second or shorter. While Ektacolor L may be exposed between 1/10 second and 60 seconds, it is available only in sheet film.

PROCESSING COLOR NEGATIVES

Kodak Ektacolor Professional Film, Type S, Type L, and Kodacolor-X film are all processed in Kodak color film processing solution kit C-22. The C-22 processing kits are available in the 1 pint, 1 gallon sizes and are also available in individual packaged chemicals in sizes up to 25 gallons.

CAUTION: The same general rules of mixing, handling, and storage of chemicals apply to C-22 chemistry as to other chemicals. More specific information on procedures for the C-22 process is covered in NavPers 10355-A, Photographer's Mate 3 & 2, chapter 17.

KODAK VERICOLOR

Kodak Vericolor films, recently introduced by Eastman Kodak, are quite similar to the Ektacolor professional films. The main differences are in the processing and printing procedures. There are two types of Vericolor available, type S and type L. Type L is available only in sheet film. Type S is available in sheet film, 120, 220, and 35mm and in 70mm roll film sizes. The exposure requirements for Vericolor films are the same as the Ektacolor professional films; 1/10 second or shorter for type S, and 1/10 second to 60 seconds for type L. Vericolor negatives are processed in a Versamet color processor model 145 using Vericolor chemicals. The processing temperature is 100°F and the processing time approximately 10 minutes. Vericolor negatives do not have the same printing filter pack requirements as Ektacolor negatives, so they must be kept separate from Ektacolor negatives during color analyzing and printing. Vericolor negatives can be printed on the same type materials as Ektacolor negatives.

MAKING INTERNEGATIVES

Although positive color transparencies can be printed directly on Kodak Ektachrome paper, color prints made on Kodak Ektacolor Professional paper may be desired. If this is the case, it is necessary first to make an internegative from the transparency to be printed. Internegatives may be made on either Kodak Ektacolor Professional Type L or Kodak Ektacolor Internegative film. Masking of the transparency is recommended when making the internegative on Type L, since the colored couplers in Type L film do not correct for the dyes in the transparency. However, Kodak

Ektacolor Internegative Film is designed specifically for this purpose and its use is covered in the following paragraphs.

Internegative Film

Kodak Ektacolor Internegative Film is a sheet film designed for making color internegatives and color copy negatives with 3200 K lamps at exposure times ranging from 1 to 16 seconds. This film, if properly used, provides color and tone-scale corrections that make excellent quality color reproductions possible without masking the transparency. This film is available in 4 x 5, 5 x 7, and 8 x 10 inch sheets.

Ektacolor Internegative film must be handled in total darkness. Exposed film should be processed as soon as possible after exposure to avoid changes in the latent image. For best results, unexposed film in its original sealed package should be kept in a freezing unit at 0° to -10°F. Remove the film package about 3 hours before opening it to prevent condensation of moisture.

Internegatives From Transparencies

These instructions assume an exposure time of 10 seconds, although times from 1 to 16 seconds can be used without changing the characteristics of the internegatives greatly. The effect of increasing the exposure time is to shorten the available latitude of the internegative film. The following procedures should yield good internegatives from most transparencies or subjects being copied, but some exposure adjustment may be necessary to produce optimum highlight or shadow contrast in unusual subjects. Within limits, increasing exposure of the internegative film increases the contrast of the reproduction, whereas decreasing exposure decreases contrast. The change in overall exposure level to obtain more density in the internegatives (higher contrast) or less density (lower contrast) can be made by adjusting either the exposure time or the light intensity, or both.

CAUTION: Do not expose Kodak Ektacolor Internegative Film for times shorter than [illegible] second or longer than 16 seconds, because [illegible] resulting negatives may contain color-reproduction errors that cannot be corrected satisfactorily in the printing operation.

1. Make exposures by contact or projection with an enlarger equipped with a Photo Enlarger Lamp No. 302, or with a light source of equivalent color quality. The exposing device should be equipped with heat-absorbing glass (such as Pittsburgh No. 2043) and means for holding filters. Adjust the illumination at the exposing plane to 3 foot-candles; then reduce the intensity by the equivalent of about 2 1/2 stops. The reduction can be effected either by using a smaller lens opening or adding a Kodak Wratten Neutral Density Filter, No. 96, of 0.70 density.

2. Add the following trial filter pack, made up from Kodak Color Compensating (CC) Filters or Kodak Color Printing (CP) Filters: 20M + 50Y.

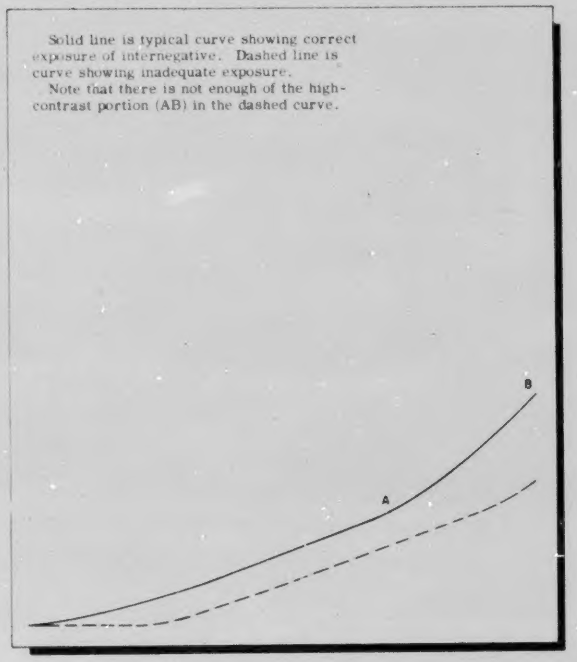
NOTE: Only CC filters can be used in the path of image-forming light.

3. Make a 10-second contact exposure through a Kodak Photographic Step Tablet No. 2 or No. 3 onto a strip of internegative film.

4. Process the exposed strip and read the density of each step with a suitable instrument, such as a stable electronic densitometer equipped with the following Kodak Wratten Filters: No. 92 (red), No. 93 (green), and No. 94 (blue). Since all three filters transmit in the infrared, the densitometer should also be equipped with a filter which transmits in the visible and rejects much of the near infrared. Such an infrared rejecting filter will restrict measurements to the red, green, and blue regions.

5. Using separate sheets of paper, plot the red, green, and blue densities of the strip for each step of the step tablet. The Kodak Color Process Record Form No. Y-55 is a suitable rectangular co-ordinate graph paper. Use red, green, and blue pencils for plotting, respectively the red, green, and blue densities. The method of plotting, drawing, and interpreting characteristic curves is discussed in Practical Densitometry (Kodak Sales Service Pamphlet No. E-59, available on request), and in chapter 6 of this manual.

The slope at the high-density end of each curve should be higher than the slope of the low-density portion of the curve. In other words, there should be an upward curve at the high-density end. This upward curve, representing higher contrast, is necessary to keep the

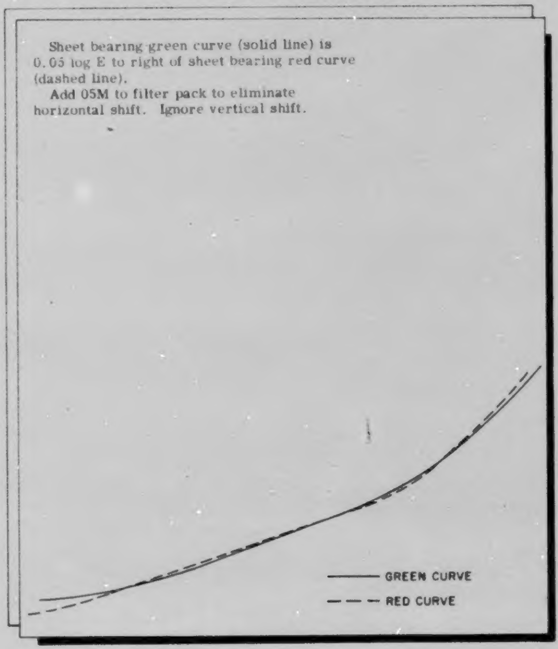


Solid line is typical curve showing correct exposure of internegative. Dashed line is curve showing inadequate exposure.

Note that there is not enough of the high-contrast portion (AB) in the dashed curve.

PH.391

Figure 5-1.—Typical internegative curve.



Sheet bearing green curve (solid line) is 0.05 log E to right of sheet bearing red curve (dashed line).

Add 05M to filter pack to eliminate horizontal shift. Ignore vertical shift.

PH.392

Figure 5-2.—Green curve superimposed on red curve.

highlights of the scene from losing contrast on reproduction. (See fig. 5-1.)

If the upward-curved portion is not obtained on one (or more) of the curves, the exposures for that particular color should be increased on a second trial. For example, if the green-density curve shows no upward curve, a second trial should be made with less magenta in the filter pack, thus increasing the green exposure.

6. Using the red curve as the reference curve, place the green curve on top of it on an illuminator. Superimpose the high-density and straight-line portions of the two curves as well as possible by shifting the sheets of graph paper in both horizontal and vertical directions (keeping the axes parallel). If the sheet bearing the green curve is to the right of the sheet bearing the red curve, add a corresponding amount of magenta filtration to the filter pack. Ignore any vertical shift between the two sheets. (See fig. 5-2.)

For example, suppose that the green sheet is approximately 0.05 log E to the right of the red sheet. Add on 05M filter to the pack. If the green sheet had been 0.05 log E to the left of the red sheet, it would have been necessary to subtract 05M filtration from the pack (or add 05G filtration).

The general rule is:

Green or blue sheet to the right of red sheet, add complementary.

Green or blue sheet to the left of red sheet, subtract complementary.

7. Leaving the red curve on the illuminator, replace the green curve with the blue curve. Whereas the green curve usually superimposes readily on the red curve, more difficulty may be encountered with the blue curve. The blue curve tends to deviate in the lower densities and some compromise may be necessary.

Again, determine the amount of horizontal shift required to make the curves match, and adjust the filter pack accordingly. For example, if, after the curves have been superimposed as well as possible, the blue sheet is approximately 0.30 log E to the right, add 30Y filtration to the pack. Conversely, if the blue sheet had been, say, 0.10 log E to the left, it would have been necessary to subtract 10Y from the pack.

8. Using the modified filter pack and exposure level determined in Steps 6 and 7, make an exposure series, using a transparency with good highlights and shadows. An exposure range of one stop above and one stop below the selected level is suggested, with the change in intensity rather than time. Process the internegatives and make the best print possible from each on Kodak Ektacolor Professional Paper or Kodak Ektacolor Print Film. Choose the best internegative exposure by inspecting the prints.

9. Inspect the test print made from each of the three internegatives for evidence of undesirable color effects in the lighter densities and highlights relative to the rest of the scene; these effects result from errors in matching the high-density portions of the curves in Steps 6 and 7. They can be corrected by changes in the filter pack for a remake of the internegative according the the following rule: Add a filter of the same color as the shift desired. For example, if the highlights are green, a color shift toward magenta is needed, and magenta filtration should be added to the pack. A filtration change of 15M will produce a significant effect.

The filter pack and exposure level determined in Step 9 can be used for the vast majority of transparencies. Within limits and with experience, it is possible to adjust the filter pack to change color contrasts in an original transparency to produce an improved copy. Similarly, an exposure change can be used to modify the overall contrast of the copy.

Repeat Steps 1 through 9 for each new emulsion number of Kodak Ektacolor Internegative Film. If the same film emulsion is used over a period of several months with storage at 35°F, it is suggested that these steps be repeated about once a month to test for and adjust for any changes that may occur.

Copy Negatives

With suitable exposure calibration, Kodak Ektacolor Internegative Film can be used for copying reflection originals with 3200 K lamps or other tungsten sources. As in the case of internegatives from transparencies, the contrast can be controlled to a considerable degree by changing the overall exposure. Contrast increases as exposure is increased and decreases as exposure is decreased.

The procedure for exposure calibration of an emulsion is the same as outlined for internegatives, except that a Kodak Gray Scale, included in Kodak Color Separation Guides, is used in place of a step tablet. This scale has density values printed adjacent to each step. With the suggested filter pack, 90Y (made up of CC Filters over the lens or CP Filters over the light source), make a test exposure, using an exposure index of 0.5 and an exposure time of about 10 seconds. Continue as described in Steps 4 to 9.

The 17 paragraphs above are derived from Kodak Ektacolor Internegative Film Data Sheet, KP52161c, 1-63, with express permission of the Eastman Kodak Company, Rochester, N.Y.

Processing

Kodak Ektacolor Internegative Film is processed in Kodak Color Film Process C-22 chemicals except for the developer. The developer is prepared from Kodak Internegative Replenisher, Kodak Internegative Starting Solution, and water. The mixing instructions are printed on the label of the Starting Solution bottle. It is important to follow these instructions carefully, being sure to use the required amount of water.

The developer must be maintained at 75°F and may not vary more than one-half degree F. Proper agitation is extremely important when processing Ektacolor Internegative Film. After the initial agitation (described in the C-22 process) the agitation consists of a 2-second burst of nitrogen every 15 seconds. After 2 1/2 minutes in the developer, remove the film rack and reverse its direction end-for-end and reimmerse. After the developer, the remaining processing steps are carried out in the same manner as the C-22 process.

KODAK EKTACOLOR PROFESSIONAL PAPER

The printing of color negative material to a positive print may be accomplished in several ways. Presently, the use of Kodak Ektacolor Professional Paper is the most desirable. Kodak

Ektacolor Professional Paper is designed for making high quality color prints from Kodacolor and Ektacolor negatives.

Kodak Ektacolor Professional Paper has three emulsions coated on a medium weight paper base. The arrangement of the sensitive layers differ, however, from the classical order of sensitivity. The red sensitive layer is on top, the green sensitive layer is in the center, and the blue sensitive layer is on the bottom. The sensitivity of the red and green layers has been adjusted so as to make unnecessary the employment of the yellow filter required by most other color emulsions. Each emulsion layer will form a dye, (during development) complementary to the sensitivity of that layer. For example, the red sensitive layer will form a cyan dye, the green sensitive a magenta dye, and the blue sensitive a yellow dye.

In the forming of a positive image on negative type color papers, the subtractive method is again used. For example a green object in the original scene will affect the green-sensitive layer of the film, causing a magenta dye to be formed in the green-sensitive layer of the film during development. When the negative is printed, white light passing through this magenta layer will affect the blue-red sensitive layers of the printing paper. This causes cyan (C) and yellow (Y) dyes to form. The final result by the subtractive method (green equals cyan plus yellow) is a positive green image of the original green object on the printing paper.

STORAGE

Proper storage of Kodak Ektacolor Professional Paper is extremely important. The print material is protected from moisture, vapor, and light by a laminated bag within the box. After opening this bag, do not remove and place its entire contents in the box. After the paper to be exposed is removed from the bag, press out the excess air in the bag, make a doublefold in the open end and secure the end of the bag with tape or a rubber band. This procedure will restore the moisture barrier around the unused paper.

Prolonged exposure of unprocessed paper to temperatures above 50°F will noticeably affect the color balance. When paper is to be stored for long periods of time, it is recommended that the unopened packages of paper be placed in a freezer operating at 0° to -10°F. The usual precautions to prevent moisture condensing on the paper must be taken when removing the paper from cold storage.

EQUIPMENT

Two general methods of exposing Kodak Ektacolor Professional Paper are presently in use, the white light method and the "tricolor" method. The tricolor method requires three separate exposures to produce a print, one of each through a red, green, and blue filter. To change the final color balance of the print, the relative length of exposure is varied between the three filters. Tricolor printing has two advantages. First, a smaller monetary investment in filters is required. Second, the loss of image definition is reduced due to the use of only a single filter at a time in the image-forming beam of the enlarger. Of course in the white light method if the filters are used between the lamp and the negative, the loss of image definition will be eliminated. Tricolor printing is widely used in the field of commercial photography being applicable to high production printers.

The white light method requires only one exposure to produce a print, and is based around the "master filter pack" for printing production negatives. It is accomplished by placing one or more filters in the light beam of the enlarger to alter the color balance of the printing light or "white light" to suit the individual negative. The white light method appears to be the most popular, particularly among the military photographers, so this section will deal primarily with this method of printing.

Any make enlarger may be used in this method of printing, provided it has the following items and features. A tungsten light source (similar to the G.E. No. 212, 302 enlarging lamp or one of suitable quality), a heat absorbing glass, a color head, a color corrected lens, a Wratten Filter No. 2B (ultraviolet absorbing), and a control for regulating the voltage. Fluctuations in line voltage are more common than is generally realized, and affect both the light output and the color quality of a tungsten lamp. As little as a 5-volt variation in the normal operating range (100-125 volts) changes the lamp output by about 15 percent, and therefore the color quality of the light by about one CC10 filter. This effect is greatest with the blue portion of tungsten light and least with the red portion.

Though it is probably best to standardize on a constant 105 volts, almost any constant voltage unit is satisfactory. The unit should be equipped with a voltmeter to insure that the proper voltage is maintained. New printing lamps should have a one hour burn-in period before being utilized. Enlargers should be as lighttight as possible and illuminated timers and safelights avoided.

FILTERS

Eastman Kodak Company manufactures two types of filters which may be used in printing reversal and negative type color films by the white light method: Kodak Color Printing Filters (CP) and Kodak Color Compensating Filters (CC). These filters are used in addition to the Infrared Cut-Off filter and the ultraviolet absorbing filter already placed in the enlarger's lighting system.

Color Printing filters (made of acetate film) are for use in enlargers which permit the insertion of filters between the light source and the negative carrier. The advantage of these filters is that they are less expensive than the CC gelatin-film filters. However, unlike CC filters, CP filters CANNOT be used below the lens in the path of the image-forming light without affecting the definition of the print. CP filters are supplied in four colors: red, cyan, magenta, and yellow. They are not supplied in blue or green, because the number of filters between the lamp and the transparency is not important. The proper combinations of cyan, magenta, and yellow filters can be used to obtain blue or green if needed. The CP filters are supplied in densities of 0.05, 0.10, 0.20, and 0.40; the cyan series has one additional density of 0.025. The density designation applies only to the color of light the filter is designed to absorb. For example, a CP10M filter is colored magenta and has a green absorbing density of 0.10.

Color compensating filters (made of gelatin) are for use at the lens or between the light source and the transparency. They are more expensive than the acetate CP filters, but since they can be used at the lens, much smaller filters can be employed. It is important to use the smallest possible number of filters at the lens to avoid flare and loss of definition. For this reason, CC filters are made in a greater number of densities and colors than the CP filters. Thus, it is possible to obtain almost any color and density combination desired with not more than three CC filters. A thorough understanding of the use of color compensating filters is imperative to successful printing, both in reversal color material and negative color material.

The Kodak Color Compensating Filters are supplied in six colors. These colors are yellow, magenta, cyan, red, green, and blue. The green and blue filters are supplied in six densities, 0.05, 0.10, 0.20, 0.30, 0.40, and 0.50. The cyan, magenta, yellow, and red filters are supplied in the above densities plus an additional density of 0.025.

Probably the main source of trouble in the exposure of color print materials is the photographer's uncertainty as to how the various CC filters should be added and subtracted in order to arrive at the simplest combination of filters possible at the lens. There are two reasons why the combination of filters used together should be held to a minimum: to prevent the scattering of light from affecting the definition of the prints, and to eliminate neutral density. Neutral density will increase the exposure time without affecting color correction.

The best plan to follow when attempting to determine filter combinations is to think of all filters in terms of the subtractive colors. Keep in mind the filter relationships explained in table 5-2 and illustrated in figure 5-3.

Based on the relationships shown in table 5-2 and figure 5-3, the following steps are used to determine the simplest combination of filters.

Convert red, blue, and green filters to their equivalents in the subtractive colors, cyan, magenta, and yellow. For example:

CC20B = CC20M + CC20C

Note that the color density remains the same in the conversion and that the same rule applies

Table 5-2.—Filter relationships.

A RED FILTER (absorbs blue and green)	=	A YELLOW FILTER (absorbs blue)	+	A MAGENTA FILTER (absorbs green)
A GREEN FILTER (absorbs blue and red)	=	A YELLOW FILTER (absorbs blue)	+	A CYAN FILTER (absorbs red)
A BLUE FILTER (absorbs green and red)	=	A MAGENTA FILTER (absorbs green)	+	A CYAN FILTER (absorbs red)

when converting subtractive filters back to red, blue, and green. For example:

CC20C + CC20M = CC20B

When filters of the same color are combined, the densities are added and their color remains the same. For example:

CC30Y + CC20Y = CC50Y

If a filter combination contains all three subtractive colors, cancel out the neutral density by subtracting from all three filters a density equal to that of the lightest filter. For example:

CC30Y + CC20M + CC30C = CC10Y + CC10C

When a filter combination contains two different subtractive filters of equal density, substitute the equivalent single red, blue, or green filter in order to keep the number of filters at the lens to a minimum. For example:

CC10Y + CC10C = CC10G

Following the above procedure carefully will help prevent the use of a combination of filters heavier than necessary to obtain the desired color-balance adjustment.

Safelight

Kodak Ektacolor Professional Paper is sensitive to light of all colors. However, it can be

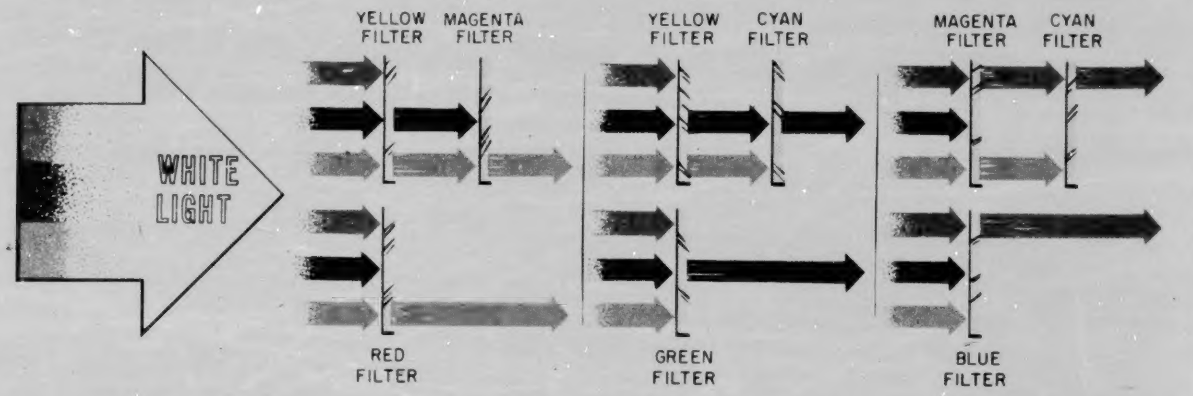


Figure 5-3.—Filter relationships.

handled for about 4 minutes at a distance of 4 feet from a suitable safelight equipped with a 7½-watt bulb and fitted with a dark amber filter (Wratten Series 10).

THE STANDARD NEGATIVE

There are several potential causes of variation in both the negative and positive stages of color printing. These causes include unavoidable manufacturing variations from one emulsion number to another, variations in storage conditions both before and after exposure, variations in color quality of illumination level and exposure time (reciprocity effect), and variations in processing. Fortunately, a wide range of adjustment is available during the positive stage, so that these variations seldom prevent making a good print.

Making a good print and doing it easily may, however, prove to be two quite different matters. To get consistently good results with as little testing, balancing, and time wasting as possible requires careful attention to instructions, good workmanship, and maximum utilization of experience. The standard-negative system, in essence, is a means of getting the greatest practical value out of experience. It is particularly well suited to white-light printing, although it can be adapted to tricolor printing.

Briefly defined, a standard control negative is an average, normal negative which has been properly exposed under known conditions and which is known from actual trial to make an excellent print. In other words, it has been printed previously, and an accurate record of the filter pack required for a particular emulsion is available. Here, therefore, is a standard which can be used for comparison purposes. The standard negative can be useful in at least three different ways: (1) for comparing printing characteristics with those of other color negatives; (2) for comparing a new paper emulsion with the old; and (3) for checking processing.

Standard-Negative Characteristics

The standard negative should be typical of the majority of negatives to be printed. If most of them are outdoor shots on Kodacolor-X film, the standard negative should obviously be an outdoor shot on Kodacolor-X film. Further, it should be normally exposed, it should be normally processed, and it should be of a typical subject with typical lighting; that is, the lighting ratio and light direction should be similar to most of the negatives that are to be printed.

It will help considerably if the standard negative contains some areas that are relatively sensitive to minor color-balance changes. For example, sunsets or flowers are not good test objects, because they can be printed over a wide range of color balance and still be pleasing. However, the face in a portrait is a sensitive area, as is any near-neutral, such as a sunlit concrete surface. Surprising as it may seem, a prominent sunlit tree trunk may be helpful in judging small color differences in middle tones and shadow areas. Best of all is a gray scale or card of 18 percent reflectance, such as the neutral gray card in the Kodak Color Dataguide, placed in the scene. Such a card lends itself to exact and reproducible measurement.

In some cases, it may be advantageous to have a "primary" standard negative for the most usual film-subject-lighting situation, plus one or more "secondary" negatives representing other situations. The basic enlarger filter pack should be determined for each negative.

Comparing Printing Characteristics

Most color negatives of the same type of subject exposed under similar conditions will print similarly, but not identically. Differences may result from variations in lighting (time of day, sky condition, etc.), variations in film emulsion, film processing, or other factors. These differences are normal and should be expected. However, the important thing is to think of these balance variations IN TERMS OF FILTER DIFFERENCES BETWEEN EACH NEGATIVE AND THE STANDARD NEGATIVE.

Thus, for making a normal print from the standard negative, suppose the filter pack consists of 40R plus 20Y, and the best print density is attained at an exposure time of 10 seconds. These filters remain in the optical system as an excellent starting point for similar negatives as long as the same emulsion number of Ektacolor Professional Paper is being used. For a particular negative, perhaps it will be necessary to add a

10M filter to the pack and adjust the printing time to 12 seconds in order to compensate for the differences between the new negative and the standard negative. In other words, the new negative prints differently from the standard negative by a 10M filter and a 20 percent increase in printing time.

Record these data with the new negative, because the relative difference WILL REMAIN CONSTANT, regardless of the characteristics of the paper emulsions which might be used in the future. For example, 6 months from now a reprint of this negative might be needed. But now a different paper emulsion is in use, and the basic filter pack in the enlarger (to print the standard negative satisfactorily) has become a 20M. It is necessary only to increase the exposure by 20 percent and add a 10M filter to the pack (or change the 20M to 30M) in order to make a normally balanced print without further test.

(The above material, commencing with the heading "The Standard Negative," is derived from pages 47 and 48 of Printing Color Negatives, Kodak Color Data Book E-66, Second Edition–Third Printing, 1966. Express permission has been obtained to use this material from the Eastman Kodak Company, Rochester, N.Y.

PRINTING

Because of the number of variables which must be brought under control in the initial setup of color-printing conditions, it is highly unlikely that a perfect print will be produced on the first attempt. The first print, therefore, must be considered a test print. The final print, to be acceptable, must be satisfactory in both density and color balance.

Significance of Tests

It is worthwhile, at this point, to consider the relationship between the two objectives, satisfactory density and satisfactory color balance. When the paper is exposed by white light, the three emulsion layers in effect divide the white light into its three primary components, just as if the paper were being exposed by the tricolor method. When a print exposed by either method is developed, the cyan dye image in the red-recording layer controls the reflection of red light from the white paper base to the eye. Similarly, the magenta dye image controls the reflection of green light, and the yellow dye image the reflection of blue light. The relationship of the three dye densities at any given point on the print governs the color synthesized there; the overall density relationship of the three dye images governs the color balance of the print as a whole.

Since the process is a negative-positive one, increasing the exposure in any of the three emulsion layers of the printing material increases the density in that layer. Conversely, decreasing the exposure decreases the dye density. Suppose, for example, that everything in a test print appears too yellowish. Since less yellow dye is wanted, a decrease in the exposure of the blue-sensitive layer is needed. In tricolor printing, this result is obtained by shortening the exposure through the blue filter. In white-light printing, it is obtained by adding a yellow (blue-absorbing) filter to the exposure filter combination, thus making the light yellower. The added yellow filter decreases the exposure in the blue-sensitive layer of the paper and hence decreases the amount of yellow dye formed.

The same type of reasoning applies when a print is too dark or too light. Perhaps the exposure in all three layers is too great or too little; perhaps one layer is correctly exposed and the other two are not. The important thing to remember is that the real objective is correct exposure in each of three layers of the print material. In tricolor printing, this goal is achieved by determining the correct exposure time through each of three filters. In white-light printing, there are two determinations to be made–exposure time and filter combination.

The reader who is planning to print by white light is encouraged NOT to think of exposure time as controlling density and filter combination as controlling color balance. This way of looking at the situation is perfectly proper, but it may not be helpful. No difficulty is encountered when either the density or color balance of the test print is satisfactory. Typically, however, the problem is to make both density and color balance corrections simultaneously. In this situation, most experienced workers find it easier to consider test prints in terms of the three separate layers. Thus, they keep in mind the fact that a change in exposure affects all three dye images. By mentally taking apart the test print and considering what needs to be done to each layer, they make the fullest use of the information given by the test print and save time and material in arriving at the final exposure conditions.

Test Conditions

First select a properly exposed color negative that is as nearly as possible typical of those to be printed. The subject should preferably include some neutral or near-neutral areas. The fact that more pictures than not include people should also be considered. Note, however, that when the most pleasing reproduction of flesh tones is obtained in a print, true neutrals (such as the gray card of 18 percent reflectance, or the gray scale in the Kodak Color Dataguide) may be reproduced with a slight bluish color.

The emulsion side of a Kodacolor-X negative (or Ektacolor rollfilm negative, if frame-numbered) is toward you when the arrow along the edge is pointing in a clockwise direction around the negative. The emulsion side of an Ektacolor sheet film negative is toward you when you are holding the film with the long edge vertical and the code notch at the upper right-hand corner.

Mask the selected negative with a black paper mask having an opening about the same size as the image area to be printed. Then make sure the negative is free from dust and place it in the enlarger so that its emulsion side is down (toward the lens). ELIMINATION OF STRAY LIGHT AROUND THE EDGES OF THE NEGATIVE IMAGE IS ABSOLUTELY ESSENTIAL. Stray light can be reduced with the slides built into some enlarger heads. In general, however, it is better to use such slides in conjunction with a black paper mask, rather than to rely on them completely.

(The above material, commencing with the heading "Printing," is derived from pages 22 and 23 of Printing Color Negatives, Kodak Color Data Book E-66, third Edition—Third Printing, 1966. Express permission has been obtained to use this material from the Eastman Kodak Company, Rochester, N.Y.)

Trial Exposure

For the first trial print, place a CC-50R filter in the enlarger and make a series of staggered exposures on a strip of Kodak Ektacolor Professional Paper. This is done by covering about four-fifths of the test strip with black paper, and giving an exposure twice the estimated time. Then, uncovering about one-fifth of the strip at a time, follow with exposures equal to the estimated time, half of it, one quarter, and again one quarter. Following this procedure will center the estimated exposure time on the strip, and the total exposure time of each step will be half that of the preceding step. For example, assuming that the estimated trial exposure time is 10 seconds at f/11 for a 2X enlargement, the test strip will have exposures of 40, 20, 10, 5, and 2 1/2 seconds.

Judging Test Prints

It is always best to evaluate test prints under light of the same intensity and color quality as that under which the final print is to be viewed. Study the color balance and density level of the test print. Look at areas that should be reproduced as whites or grays, and decide whether they have been affected by some variation from neutral color balance. Look at the reproduction of highlights and decide whether overexposure has caused them to be muddy or underexposure has caused them to lose detail.

Some changes in exposure conditions will probably seem desirable. If the test print is far from the proper density or color balance, the changes required can probably be estimated only roughly. A second test will be needed before the final print(s) can be exposed.

If the test print is reasonably close to being satisfactory, it should be possible to predict the final exposure conditions with sufficient accuracy. As emphasized at the beginning of this section, the experienced worker tries to think of the test print in terms of its three separate dye images. Until experience is gained, however, it may be helpful to view test prints through color compensating filters.

USE OF VIEWING FILTERS.—If a test print is reasonably close in color balance, viewing it through Kodak Color Compensating Filters provides a means of determining what color is needed. Since a filter used in this way tends to overcorrect highlights and undercorrect shadows, it should be selected on the basis of correcting the lighter middle tones to the desired color balance. Be sure to view the print under proper lighting conditions, and hold the filter neither so close to the print that the light falling on the print passes through the filter first, nor so close to the eye that the filter influences general color adaptation.

Since the contrast of the print material is fairly high, a filter used in exposing a print tends to produce a greater change in color balance than might be expected from the effect of a filter of the same strength used in viewing. In general, the complementary filter added to the filter pack for white-light printing should be half the strength of the filter that makes the lighter middle tones of the test print appear best.

Suppose, for example, that the test print is too green—that is, the magenta dye image is too light relative to the cyan and yellow dye images. The print will look best through a magenta filter, but getting relatively more exposure into the green-sensitive layer where magenta dye is formed means ADDING GREEN filtration to the pack or REMOVING MAGENTA filtration. If a 20M filter was best for viewing, removing a 10M filter from the pack should accomplish the desired correction.

MODIFYING THE FILTER PACK.—When it has been decided which color predominates in the test print, a filter of that same color can be ADDED to the pack. However, it is more desirable to SUBTRACT a complementary filter, and this procedure should be adopted whenever possible.

Table 5-3 may be useful in determining what filter adjustment should be made in white-light printing.

For example, as shown in table 5-3, if the print is too red, remove a cyan filter from the filter pack. If there is no cyan filter present in the filter pack, add yellow and magenta filters (or the equivalent red filter).

Table 5-3.—Determing filter adjustment (Ektacolor Professional Paper).

If the color balance is	If possible, subtract	or	Add
Yellow	Magenta and cyan (or blue).		Yellow
Magenta	Cyan and yellow (or green).		Magenta
Cyan	Yellow and magenta (or red).		Cyan
Blue	Yellow		Magenta and cyan (or blue).
Green	Magenta		Cyan and yellow (or green).
Red	Cyan		Yellow and magenta (or red).

The following rough guide may also be helpful: When a slight shift in color balance is needed, use an 05 or 10 filter change; when a moderate shift is needed, use a 15 (05 plus 10) or 20 change; and when the shift required is too large to estimate, try a 30 change.

The effect of filter changes on exposure must be kept in mind. For example, if diffuse whites in a test print are reddish, it may work out well to add a 10R filter or 10M plus 10Y to the pack and use the same exposure again. On the other hand, correcting the color balance by removing a 10C filter will definitely call for a decrease in exposure.

(The above material, commencing with the second sentence under the heading "Judging Test Prints," is derived from pages 27, 28, and 30 of Printing Color Negatives, Kodak Color Data Book E-66, Third Edition—Third Printing, 1966. Express permission has been obtained to use this material from the Eastman Kodak Company, Rochester, N.Y.)

PROCESSING

Ektacolor Professional Paper is intended for processing by the user. Kodak Ektaprint C Chemicals are made for this purpose and are supplied in kits of 1 gallon and 3 1/2 gallon sizes, or individual packaged chemicals in sizes from 1 to 150 gallons

These instructions apply to batch processing in tanks. In the tank method, a processing basket is used. Some models of these baskets hold as many as forty-eight 8 x 10 prints, when used in a 3 1/2 gallon tank.

Precautions in Handling Chemicals

Agents used in color processing chemicals may be absorbed through the skin and into the blood stream and organs of the body and/or cause skin irritations. In case of contact of solutions or solid chemicals (especially developer, developing agent, or bleach) with the skin, wash at once with an acid type hand cleaner, such as pHisoderm or pHisohex, manufactured by Winthrop Laboratories; pH6, manufactured by Stepan Chemical Co.; or Sulfo Hand Cleaner, manufactured by West Chemical Products, Inc.; and rinse with plenty of fresh water. The use of clean rubber gloves is mandatory especially in mixing or pouring solutions and in cleaning the darkroom. Before removing gloves, rinse their outer surfaces with acid hand cleaner and water. Keep all working surfaces, such as bench tops, trays, tanks, and containers, clean and free from spilled solutions or chemicals. Safety precautions pertaining to photography can be found in chapters 17, 18, and 20, articles 2001, 2002, 2003, 2005, 2006 and section 4 of article 2007 of NAVMAT P-5100, Safety Precautions for Shore Activities, and NAVWEPS 10-1-764, Safety Precautions for Photographic Personnel. Photographic personnel are required to know and follow these detailed safety precautions.

Contamination of Solutions

The photographic quality and life of the processing solutions depend on the cleanliness of the equipment in which the solutions are mixed, stored, and used. In particular, small quantities of the Stop-Fix or Formalin Fixer in the Developer will seriously impair print quality. The best procedure is to use the same processing and storage tanks for the same solutions each time, and to make sure that each is thoroughly washed before refilling. Mixing chemical solutions in printing and processing areas should be avoided. By the same token, any solutions spilled during processing should be promptly cleaned up with one of the cleaners mentioned in the preceding paragraph. Chemical dust can cause spots on prints.

Replenishment of Solutions

When used as directed, replenishers increase the capacity of the working solutions to a maximum and extend their life considerably. There is also a saving of time in mixing. Another important advantage is the improved control of color balance and speed obtainable by making gradual compensation for the use and aging of the solutions.

Replenishment should be performed as frequently as possible, preferably after each batch of prints, using quantities of the replenisher solutions proportional to the area of paper processed. Replenishment tables are furnished in the information sheet that comes with each Ektaprint C Kit for a guide and should be modified as necessary to suit individual working conditions.

Tank Processing

Proper agitation is very important. Upon placing the basket in each chemical solution, AGITATE CONTINUOUSLY FOR 15 SECONDS; THEN AGITATE FOR 5 SECONDS EACH MINUTE THEREAFTER. The agitation should consist of a rapid up-and-down movement of about 2 inches; do not lift the basket (paper) out of the solution. Be sure the cover is on the processing basket. The initial 15-second hand agitation should be given in each chemical solution; for subsequent agitation in each solution, gaseous-burst agitation is preferable because it is a simpler and more uniform method of operation. The recommended practice is a 1-second burst of gas every 12 seconds, at a pressure sufficient to raise the solution level about 5/8 inch with each burst. Nitrogen must be used in the developer; compressed air can be used in the other solutions if it is free from oil.

Temperature

Good results depend on accurate control of processing temperatures in the developer. Variations of more than ±1/2°F from the standard temperature of 85°F, at this stage, should be avoided. The wash water and other solutions can be used at 83°-87°F or, with longer times in treatment, at 73°-77°F.

Timing

The time for each processing step includes the drain time (20 seconds). In each case, start draining in time to end the processing step (and start the next one) on schedule. Specific times of treatment are given in the Summary of Steps for batch processing, the information sheet that comes with each Ektaprint C Chemical kit.

Washing

Washing procedures are important for print quality and print life. The minimum wash-water flow rate in each of the washes should be 0.15 gallon per minute per square foot of paper. In a 3 1/2 gallon tank, the rate should be at least 2 gallons per minute. In basket systems larger than 10 gallons, the flow rate is 1/10 of the wash tank volume, but no less than 5 gallons per minute.

If the prints tend to become covered with small air bubbles, which decrease washing efficiency, install a filter pump in the water line. Adjusting the pump to give a steady flow of large bubbles into the line, will prevent the formation of small bubbles on the print surfaces.

Drying

Prints can be air-dried or ferrotyped. They can be cold-ferrotyped directly on chromium-plated plates that are free from scratches. Prints can be hot-ferrotyped on a stainless-steel drum dryer operated at a temperature not above 180°F. Ferrotyping surfaces must be cleaned frequently to prevent accumulation of dirt deposits.

Supplementary Information

In general, it is suggested that the printed information sheets that accompany the color processing kits be referred to for more complete and up-to-date information on procedures and product improvements.

Processing Faults

Several variables in processing can affect the quality of color prints adversely. Some of the more common causes underlying quality losses are lack of cleanliness, incorrect mixing of solutions, incorrect use of solutions, contamination of solutions, and lack of adequate control in the processing procedure.

Some common sensitometric problems in processing Kodak Ektacolor Professional Paper are as follows:

STAIN caused by over development or inadequate Stop-Fix treatment.

DARK PRINTS caused by overdevelopment.

LIGHT PRINTS caused by underdevelopment.

PINK HIGHLIGHTS caused by underdevelopment.

MAGENTA SHADOWS caused by processing solutions used only intermittently. (Often occurs on the first run after processing solutions have been left unused over a weekend. With second run, results are usually back to normal.)

BLUE SHADOWS caused by dilute, under-replenished, or exhausted Bleach.

Tables 5-4 through 5-7 may be used to check for possible causes of unsatisfactory results due to spots, mottle, stain, streaks, and physical marks.

(Portions of the material in this section and that contained in tables 5-4 through 5-9 are derived from Errors in Processing Kodak Ektacolor Professional Paper, Kodak Sales Service Pamphlet No. E-51. Express permission has been obtained to use this material from the Eastman Kodak Company, Rochester, N.Y.)

KODAK EKTACHROME RC PAPER

Kodak Ektachrome RC paper is a multilayer color material designed for direct printing or enlarging of color transparencies, with a single

Table 5-4.—Unsatisfactory results due to spots.

	Chemical contamination			Other causes		
Magenta				Iron or rust particles in wash water. *		
Red	Fixing bath splattered on print near end of processing. *	Pitted metal ferrotyping surface.	Contamination from Part A developer dust.			
Pink						
Brown						
Blue			Contamination from chemical dust.†	Inadequate agitation in Bleach		
Green				Inadequate agitation in Stop-Fix		
Cyan						
White				Water splashed on prints before or during processing.	Air bubbles on emulsion during development.	Moisture condensation on cold paper.

*Spots may not appear until later or unless prints have been subjected to high heat.

†Contamination from chemical dust can occur before, during, or after processing. Do not mix chemicals near areas where paper is handled.

Table 5-5.—Unsatisfactory results due to mottle.

	Chemical contamination	Inadequate treatment		Excessive treatment	Other causes
Magenta	Formalin Fixer carried over into Buffer.*	Inadequate Buffer treatment.*			
Red		Low wash rate before Bleach.			
Pink					
Blue (on back of prints).	Iron contamination from processing equipment or water.	Inadequate washing after Bleach.†	Inadequate Formalin Fixer.		
Blue	Bleach carried over on drying equipment.	Exhausted or insufficient Formalin Fixer.	Inadequate agitation in Bleach.	Print flattener too concentrated or prints treated for too long a time.‡	
Cyan	Developer contaminated with Stop-Fix or Formalin Fixer.		Inadequate agitation in Stop-Fix.		
Green					
White					Moisture condensation on cold paper.
Blotchy Backgrounds		Inadequate agitation.			

*Mottle may not appear until later or unless prints have been subjected to high heat.
†Typical of prints placed back to back in a processing basket.
‡Mottle may appear as a lacy pattern.

Table 5-6.—Unsatisfactory results due to stain.

	Chemical contamination	Inadequate treatment		Other causes
Magenta	Developer carried over into Bleach.	Inadequate agitation.		
Red		Insufficient time in Stop-Fix, or exhausted Stop-Fix.	Low wash rate or poor wash cycle. *	
Pink				
Pink (on back of prints).				
Cyan	Developer contaminated with Stop-Fix or Formalin Fixer.			
Yellow	Stop-Fix contaminated with Formalin Fixer.			Scorching during dry mounting.

*Especially before bleach.

Table 5-7.–Unsatisfactory results due to streaks and physical marks.

	Improper Exposure	Processing Faults					Improper Drying Techniques		Other Causes
Red Marks							portion of top (cyan) layer removed*		
Cyan or Blue Streaks	fog from red lights†	excessive carry-over of Developer into Stop-Fix		inadequate agitation in Stop-Fix (See Spot Chart)					folds or kinks in paper before processing
Yellow-Green or Blue Streaks on One Edge		solution level of Developer too low							
Brown Streaks	fog from white light‡								
Brown or Black Specks		sludge or scale from dirty Developer tank							
Blotchy Backgrounds		prints in contact with plastic screen							
Screen Pattern		prints not removed from basket while still in Stabilizer	basket not washed and dried thoroughly before use	if white, increase agitation in Developer	if blue, increase agitation in Bleach	if gray, increase agitation in Stop-Fix	prints not squeegeed before drying		
Dimples or Indentations								uneven drying	
Scum		precipitate caused by Bleach carried into Stabilizer	inadequate wash after Bleach	hard-water salts in Stabilizer	inadequate agitation in Stabilizer	fine precipitate in Stabilizer	ferrotyping surface not clean		
Rough, Blistered Emulsion		gel deposit from foam in processing solutions							
Tacky Prints		excessive print flattener	excessive stabilizer, Type 2						
Desensitized Areas									pressure applied to back of prints§

*Often caused by pits in the ferrotyping surface.
†Through paper base if watermark shows.
‡Probably light leak in printer.
§Often caused by writing on back of print before processing.

exposure. Any good color transparency can be printed on Ektachrome RC paper. The transparency should have plenty of color as there is some loss in color saturation, and an already drab transparency will appear even worse as a print. The original transparency should be sharp, with plenty of detail, for in most cases enlargements will be required. Transparencies that are slightly too warm or too cold may be corrected somewhat in printing. However, the best results will be obtained only from a properly exposed transparency with the correct color balance.

EQUIPMENT AND METHOD OF PRINTING

The same equipment used for printing Ektacolor Professional Paper can also be used for Ektachrome RC Paper. Adjusting the filter pack to obtain the correct color balance for Ektachrome RC Paper is the opposite of the method used for Ektacolor Professional Paper. For example, the color balance of an Ektacolor print is corrected by either adding the color desired to be eliminated or reduced or subtracting its complementary colors. The color balance of an Ektachrome print is corrected by either subtracting the color desired to be eliminated or reduced or adding its complementary colors. If the color balance of an Ektacolor print was too magenta you would subtract cyan and yellow (or green) or add magenta. If the color balance of an Ektachrome print was too magenta you would either subtract magenta or add yellow and cyan. Whenever possible, subtract filters from the filter pack.

Table 5-8 may be useful in determining what filter adjustments should be made in printing Ektachrome RC papers.

To assist in determining the filter adjustments to be made, an area in the print which should appear as a neutral (gray) should be examined.

Table 5-8.—Determining filter adjustment (Ektachrome RC paper).

If the color balance is	If possible subtract	or add
Yellow	Yellow	Magenta and Cyan
Magenta	Magenta	Yellow and Cyan
Cyan	Cyan	Yellow and Magenta
Blue	Magenta and Cyan	Yellow
Green	Yellow and Cyan	Magenta
Red	Yellow and Magenta	Cyan

Any undesirable color tint can then be readily noticed. Ektachrome RC Paper must be handled only in total darkness when printing.

STORAGE TEMPERATURES

High temperatures and/or high humidities will adversely affect all unexposed/unprocessed color papers. To avoid color shifts and changes in the latent image the paper must be kept cool and dry, and processed as soon as possible after exposing. The same storage conditions and temperatures that applied to Ektacolor professional paper also apply to Ektachrome RC.

PROCESSING

Ektachrome RC Paper is intended for processing by the user with Kodak Ektaprint R chemicals. These chemicals are supplied in kits of 1 gallon, 3 1/2 gallons or individual packaged chemicals in sizes from 1 to 150 gallons. Ektachrome RC Paper can also be processed with the Kodak Rapid Color Processor, Model 11 or 16-K at 100°F.

Drying

Ektachrome RC Paper must not be ferrotyped. A glossy surface that is comparable to ferrotyped prints can be obtained by hot-air impingement drying. Prints may also be dryed at room temperature but will have a slightly lower gloss than those dried by hot air. Do not dry prints on either blotter rolls or heated continuous belt dryers. The apron pattern may be transferred to the face of the print and, if a blotter is used, fibers from it may stick to the emulsion of the print.

Specific processing instructions are provided with the information sheet that comes with each Ektaprint R chemical kit; it is suggested that this general information sheet be referred to for more complete and up-to-date information regarding processing procedures.

RAPID PROCESSING WITH CP-5 CHEMICALS

The following is a brief description of the procedures for processing Kodak Ektacolor Professional Paper in the Kodak drum type Rapid Color Processors (Model 11 or 16K). The drum method with CP-5 chemicals can give the small photo lab a rapid and convenient, limited-production color print capability. The advantage of this method over the regular Ektaprint C process is speed; time for the CP-5 process is 7 1/2 minutes versus 25 minutes for the Ektaprint C process.

CP-5 CHEMICALS

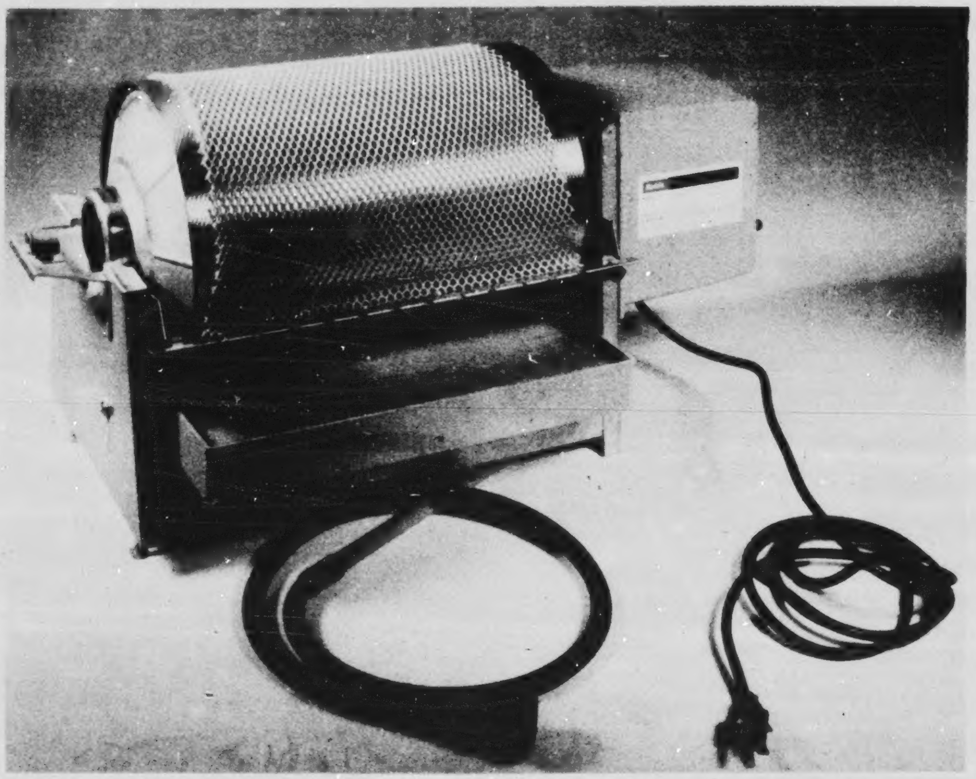
NOTE: Using these chemicals at 100°F in open trays will cause a strong and disagreeable odor. The darkroom should be well ventilated or the operator should be able to leave the room for periodic breaks. Covering the trays when not in use is another method of controlling the level of chemical odor.

WARNING: USE OF RUBBER GLOVES IS MANDATORY

Chemical warning notices appear on the carton and individual parts of the CP-5 kit. These warnings should be read and observed during the mixing and use of the chemicals.

DESCRIPTION OF KODAK RAPID COLOR PROCESSORS

The Model 16K differs from the Model 11 in that it is slightly larger and is equipped with a temperature control assembly. Processing procedures for the Model 11 and 16K are essentially



PH.394

Figure 5-4.–Model 11 Rapid Color Processor, front view.

the same. Both are standard stock and are listed on the Federal Supply Schedule.

The Model 11 processor, figures 5-4 and 5-5, is a compact (27 inches long; 12 inches high) portable machine capable of processing one 8 x 10 inch or one 11 x 14 inch Kodak Ektacolor Professional Paper print in one processing cycle. Time required is approximately 7 1/2 minutes. The processor consists of a solution tray assembly, a processing drum assembly, and a drive motor assembly.

SOLUTION TRAY

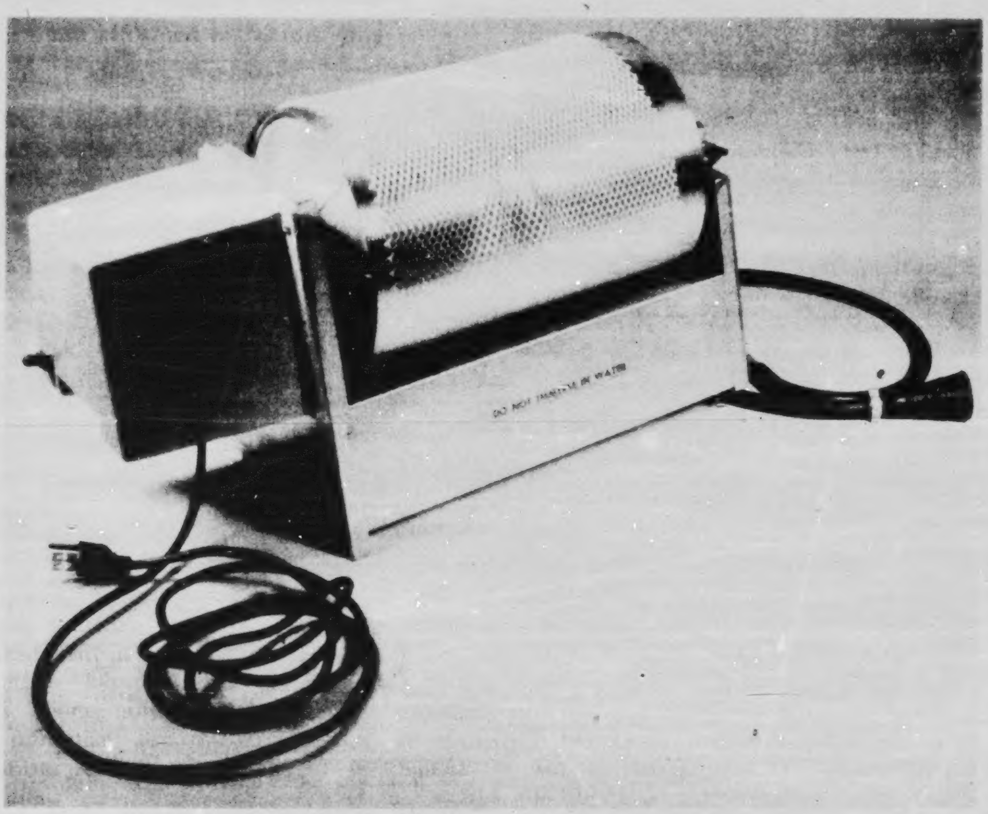
The plastic solution tray contains the required solutions during processing. It is mounted on pivot pins so that it can be tilted for rapid removal of solutions, rinsed, and then returned to normal position to accept the next solution.

PROCESSING DRUM

The processing drum supports the color print and transfers (via its textured surface) the various solutions from the tray to the emulsion. A plastic net blanket holds the print stationary on the drum during processing.

TEMPERATURE CONTROL ASSEMBLY (MODEL 16K ONLY)

The temperature control assembly heats and circulates the water used to maintain drum temperature at the required 100°F plus or minus 2° by means of an immersion heater and sump pump.



PH.395

Figure 5-5.—Model 11 Rapid Color Processor, rear view.

PROCESSING PROCEDURES

Complete processing procedures are furnished with each machine by the manufacturer; however, a brief outline is given in the following paragraphs.

Preliminary

As preliminary steps, the processor is leveled; the drum is brought to the required temperature of 100°F; the chemicals are prepared, measured, and set up in the proper sequence; the drive motor is started; the first solution is poured into the plastic tray; and the net blanket is prewetted.

Processing

The actual processing consists of prewetting the sensitized paper; positioning the paper against the net blanket; placing the blanket on the processor so that the paper is held (emulsion side down) against the drum surface, and filling and draining the chemicals in the required sequence. The processing steps, and the time required for their completion, are given in table 5-9.

After the last step (stabilizer) the print is dried in the usual manner. Following step 5, the processing may be done under full room illumination.

Some of the difficulties that may be encountered in drum processing are listed in table 5-10, Table 5-9.–Time schedule.

Step	Time
1. Presoak	30 sec
2. Develop	2 min 30 sec
3. Wash	30 sec
4. Stop-fix	30 sec
5. Wash	30 sec
6. Bleach	1 min
7. Wash	30 sec
8. Formalin-fix	30 sec
9. Wash	30 sec
10. Stabilizer	30 sec
	7 min 30 sec

along with probable causes and indicated corrective action.

ON-EASEL EVALUATION FOR COLOR PRINTING

Producing color prints, economically and on a production basis, requires a high degree of controlled repeatability and dependability on the part of the operator, solutions, and evaluation equipment. If quality assurance measures are utilized, we can assume that processing conditions are optimum and the only remaining considerations are the human factor and the equipment used to evaluate the color negative before printing. On-easel evaluation is one method used to evaluate the color negative before printing. In black and white printing test exposures may be processed and evaluated in a few minutes, to determine adjustments necessary to produce a good print. But the exposure requirement, filter pack, and inability of the average photographer to merely view a color

Table 5-10.–Drum-processing difficulties with CP-5 chemicals and the Kodak Rapid Color Processors.

Cyan stain	Copper contamination of presoak water; use distilled water if necessary				Inadequate wash after Developer; let tray fill up and dump twice	
Drum does not wet evenly	dirty drum	drum not level	processor tray not properly adjusted	chemicals poured into tray to quickly		
Drum stops rotating						
Print slides out					print not alined properly on drum	print not spaced properly from blanket bar
Pattern on print						
One edge of print darker						

negative and determine adjustment factors become time consuming and costly when applied to color photography. Evaluating the negative before printing by the on-easel method provides the exposure time and specific filter pack required for optimum print quality.

Color negative evaluation methods compare the relative proportions of red, green, and blue light transmitted by reference areas in an unprinted negative with those in a standard (master) negative. For successful negative evaluation, the reference areas evaluated must be basically the same in all the negatives. In color photography it is helpful either to include a gray card in the scene being photographed or to expose an additional negative with the gray card receiving the main illumination. All images of a gray card tend to print alike, regardless of the card's relative position to the main light. In portraiture, a medium flesh tone is sometimes elected rather than using a gray card. When this is done all flesh tones tend to be reproduced alike, regardless of individual variations in skin color or in the character of the light falling on the original scene.

NEGATIVE VARIATIONS

Few characteristics are exactly the same in color negatives, even when the subject is the same. These differences can be produced by the following variable factors:

1. Normal manufacturing variations from one emulsion coating to another.
2. Adverse conditions before exposure.
3. Illumination by light of different color quality (temperature of light source).
4. Difference in emulsion sensitivity with changes in illumination level and exposure time (reciprocity effect).
5. Adverse storage conditions between exposure and processing (latent image keeping).
6. Nonstandard processing conditions.

NB-500PA ON-EASEL COLORIMETRIC PHOTOMETER

This is a photometer in common use by the Navy which facilitates control of color balance and exposure time during negative evaluation for either tricolor or white light printing. The NB-500PA operates basically as a memory system that aids in achieving uniform reproduction, by accurately reproducing the qualities of a satisfactory print made from a master negative to which the instrument is indexed. It is not within the scope of this manual to give detailed step by step operating procedures. Complete and up-to-date operational instructions are provided with the color analyzer that will be used by the photographic lab. Therefore only a brief discussion of the NB-500PA will be presented.

The optical system is divided into two segments, probe and filter. The probe, which can be maintained anywhere on the enlarger easel, gathers light energy which is "piped" via a fiber-optic cable to the photomultiplier tube in the main housing of the analyzer. The filters wheel, also located in the main housing, contains four filters for evaluating the color balance and exposure time of the negative.

The meter scale is divided into two separate scales, as follows:

1. The exposure time scale.
2. Correction filter requirements.

The exposure time scale is a direct reading scale having divisions from 1 to 100. The correction filter scale is divided into 6 major divisions (0.1, 0.2, 0.4, 0.6, 0.8, 1.0) on either side of the null areas in the center; each 0.1 division can be interpreted as being approximately equal to a Kodak CC 10 filter. These meter readings, accurate to within plus or minus 1 percent, clearly indicate by meter markings whether filtration should be added or removed. The NB-500PA is designed for duty on a short cycle. Optimum performance will be achieved by deenergizing the unit whenever it is not in actual use.

Once the calibration control is set, upon obtaining time null indication of the meter dial, do not change the calibrate control position until the next daily calibration. Also insure that the enlarger setup is identical to that which has already yielded a satisfactory print (i.e., magnification, f/stop, time). If the enlarger with click stop lens is being used, fine adjustment for "null" indication will usually be obtained by adjusting the electronic f/stop of the analyzer. Once the analyzer has been indexed to one color criterion (reference area of the master negative) the same procedure is used to memorize the other desired color criteria of master negatives.

When analyzing production negatives, the reference area of the production negative should be comparable in color density to that of the reference area in the master negative. Processing conditions and paper emulsion for additional copies must remain the same as that used to obtain a satisfactory print from the master negative.

Unless all color enlargers in the lab are identical, so that one can be used only for the purpose of color analysis, each enlarger must have its own analyzer. The operator then performs both the analyzing and printing. Negative evaluation procedures that analyze only a small area of the negative are called "spot reading." Spot reading is the most popular and accurate method but requires analyzers that are more sensitive and stable than those used for "large area readings." Large area readings, though less accurate than spot readings, can be used in the absence of reference points in the negative (such as a gray card, flesh tones or a neutral area). Either the entire negative or a large percentage of the negative is measured and integrated densities used to determine the exposure when taking large area readings.

EKTACOLOR PRINT FILM

Ektacolor print film is designed for direct printing or enlarging from a color negative. It yields brilliant positive color transparencies which can be used for lantern slides, color displays by transmitted light, or as transparencies for photomechanical reproduction. A color negative by itself is not suitable for direct reproduction by photomechanical means.

EQUIPMENT

The same equipment, including the Wratten 2B filter and the heat absorbing glass, used for printing Ektacolor paper is used for printing Ektacolor print film. The enlarger must have a light source of sufficient intensity to avoid exceedingly long exposure times. The exposure time will depend upon such factors as the subject matter, negative density and degree of magnification. A typical Ektacolor or Kodacolor negative requires 10 to 20 seconds exposure when the illumination is 2 foot candles, measured at the printing surface and without any negative or color-compensating filter in the light path of the enlarger. Ektacolor print film is designed to be exposed at this level of illumination. Exposures and filter packs will vary at other illumination levels. Exposure is made with the emulsions of the print film and negative facing one another.

Good clear transparencies may be made either by projection or contact printing. In either event an enlarger equipped for color printing must be used as the light source. When contact prints are to be made, it is advisable to use a printing frame. The print should be backed up with black paper. Extreme care must be taken regarding dust spots. Color transparencies are generally projected upon a screen for viewing, thus magnifying any dust or other defects. For the best tonal reproduction and color balance a test transparency from each different negative is recommended. Alternate exposures may be made on one sheet of film. The test transparency may then be processed following the recommended procedure throughout. Allow the transparency to dry completely before attempting to evaluate it. Test transparencies must always be evaluated by transmitted light having the same color temperature as that by which the final transparency will be displayed.

The recommended filter pack for a color transparency is found on the supplementary data sheet packed in each box of Ektacolor print film. The method of selecting the filter pack is similar to that for Ektacolor paper. However, instead of adding only half the density, the full density of the complementary color of the viewing filter is added to the filter pack. For example, suppose the basic filter pack is adjusted to a CC-20R but the transparency appears overly yellow. The viewing transparency providing the best color balance is a CC-10B (complementary to yellow). It will be necessary to add a CC-10Y to the basic filter pack, not a CC-5Y.

Another example is the basic filter pack is adjusted to a CC-20R, but the transparency appears too blue. The viewing transparency would be yellow (complementary to blue); in this case, for example, a CC-10Y. Theoretically a blue filter should be added to the filter pack. However, the CC-10B must be converted to its primary subtractive colors, namely, magenta and cyan. Since the CC-20R will also be converted to magenta and yellow, it can be seen that there will now be neutral density in the filter pack.

The new filter pack would now be the following: CC-20R equals CC-20M plus CC-20Y; CC-10B equals CC-10M plus CC-10C. Combined this equals CC-30M plus CC-20Y plus CC-10C. Neutral density may be canceled by removing a density of CC-10 (the density of the CC-10C filter). The new filter pack should be adjusted as follows:

New filter pack:	CC-30M plus CC-20Y plus CC-10C
Subtract:	-CC-10M plus CC-10Y plus CC-10C
Adjusted pack:	CC-20M plus CC-10Y (CC-10C canceled)

The exposure for Ektacolor print film will vary according to adjustment of the filter pack, just as it does with Ektacolor paper.

PROCESSING

Ektacolor print film is processed in the same processing kit as Ektacolor film, process C-22, and with the same directions as those given for Ektacolor film, type S. The only difference is that during replenishment, Kodak Ektacolor print film additive is added to the normal developer replenisher in the amount stated on the instruction sheet.

COLOR PHOTOGRAPHY IN MULTI-SENSOR RECONNAISSANCE

One of the fundamentals of photographic physics is that a given combination of object characteristics, atmospheric conditions, energy levels, etc., will result in the formation of a definite arrangement of energy wavelengths, which, if they fall within the visible portion of the spectrum, will form a latent image on any emulsion that is sensitive in that region. Since panchromatic black-and-white, color, and infrared aero film are all sensitive to the entire visible spectrum, their images will exhibit similar patterns under proper conditions of exposure. Neither can image an object that would not appear on the other.

The individual presentations, although similar in image pattern, differ greatly in information content. In reconnaissance, black-and-white photography has the ability to resolve minute details and is an invaluable interpretation aid. Color, however, opens a new dimension to the analyst—that of tonal differentiation. While black-and-white aerial imagery records perhaps 30 discernible gray tones, color film has been known to image at least 267 distinct hues.

In essence, the information derivable by means of color and false-color photography differs significantly from that obtained with black-and-white imagery; one augments the other. Both shape and color are clues to identification in the real world or on film. Therefore, it is best to treat each as a unique sensor.

STANDARD AND SPECIAL FILMS

There are a number of suitable color films available for aerial reconnaissance. Most of these films are of the reversal type, but some can be processed to a negative when desirable. Also, there are emulsions specifically for negative use.

In addition to the regularly available color aerial products, there are a number of emulsions, vended by Eastman Kodak, called "special order" and the designating number is preceded by SO. Because these emulsions are trial coatings, or regular products cut for another application, they are not subject to regular production scheduling or quality-control standards. Since the coating is not subject to quality-control standards, there is a possibility of substantial variability in the emulsion from batch to batch. Also, these products are not kept in storage; therefore, considerable lead time in procurement is required. Costs are often about twice that of regular products. When an SO product gains acceptance, and a continuous demand for it is apparent, it becomes scheduled for regular production and is subject to control tolerances.

FILTERS

Filters used in aerial color photography are generally classified as haze cutting or emulsion correcting; the latter is usually included with the film to correct normal manufacturing variations. The gelatin coated filter is lacquered for protection. A more permanent filter, or one which will receive rough handling, is cemented between pieces of "B" glass. Filters in "B" glass can be used with short focal length lenses.

Wratten Filters, Nos. HF-1 to HF-5, are recommended for haze penetration. Selection of the appropriate filter would depend on the severity of the haze. Filter factors rarely increase exposure by as much as 1/f stop. Specific factors are included with the film data sheet. A Wratten No. 12 filter is always used with infrared emulsions, Types 8443 and SO-180. Samples of Kodak Aerial Color Film, Type SO-121, required the utilization of a Wratten No. 2E in order to correct the integral haze cutting color balance incorporated in the emulsion.

FILTERS FOR PRINTING COLOR AERIAL PHOTOGRAPHY

When printing or duplicating color aerial photography, it is probable that the EN-90 printer, equipped with a tungsten light source, or the EN-6a will be used. The tungsten light source kit for the EN-90 is equipped with the necessary filters, including neutral density filters. Filters suitable for color printing with the EN-6a are available from standard stock.

In addition there are a number of color-correction filters available which will make subtle changes in color balance.

PROCESSING CHEMISTRY

Today, the most suitable implement available for high-production color aerial photography is the EH-73 Color Versamat System. It is made up of a 14-tank roller processor and dryer, a chemical control panel to maintain precise temperature, and replenishment specifications. Process EA-5 is used in the system, and processing specifications are available for all the sensitized materials manufactured by Eastman Kodak for color aerial photography purposes. The EA-5 process, however, is not compatible with color film manufactured by others. The EH-73 is discussed in chapter 7 of this training manual.

There is evidence that distant future processing of color aerial photography will be accomplished by the diffusion transfer system similar to bimat. Another distant possibility is the reintroduction of viscous color processing systems. Utilization of viscous diffusion transfer on any processing system whereby solutions are introduced at the surface of the emulsion and immediately discarded will allow the emulsion makers greater flexibility in designing films with improved image structure and color fidelity.

CHARACTERISTICS OF COLOR FILMS

Although a variety of aerial color films exists, these films can be grouped basically into two categories: the "normal" color type, and the false color type–generally known as camouflage detection or infrared aero film.

Interpretation of "normal" color imagery is relatively straightforward. When properly exposed, colors appear very nearly as they do in the real world.

Objects tend to change their color stimulus because of atmospheric effects and the reflectance angle of the energy source. What is necessary for detailed analysis of imagery is that the degree of color distortion be minimal and constant. This can be effected by judicious mission planning and the proper use of filters.

Interpreters frequently tend to overly complicate the task of analyzing infrared aero (or camouflage detection) film. It must be remembered that the emulsion is mainly sensitive to the visible spectrum; therefore, the same patterns will be imaged on this film as by any other panchromatic medium. Color anomalies exist due to the following factors:

1. One layer of the emulsion is sensitive to the energy wavelengths emanating from chlorophyll-laden flora–it images healthy vegetation as red and diseased vegetation or camouflage as green or blue.

2. Since the greatest sensitivity is in the green, red, and infrared regions (most of the blue is filtered out), the combination of imaging in the individual layers will produce color representations unlike those featured by the original object. While this may, at times, provide an enhancing effect, it can also mislead the analyst. For instance, under certain conditions

greenish hues image the same as water. Unfortunately, no key exists to correlate all color renditions of this film.

IMAGE INTERPRETATION

Although many techniques exist to extract information from black-and-white photography, none approaches the ability of color to separate targets from their backgrounds. This is implicit in the vast disparity between the number of existing colors and the limited amount of gray steps observable on black-and-white film.

Color saves time; how much time is indeterminable. In general, it seems to vary inversely with the interpreter's experience with black-and-white imagery. It also varies with the individual target and its background. In current operations, the saving of interpretation time is neutralized by increased processing time. This, however, may be changed in the near future by the introduction of more rapid processing techniques.

For rapid scanning operations, the enhancing ability of color is an excellent aid. Either material is limited; the black-and-white in tonal differentiation, the color in resolution. Used simultaneously, their individual capabilities complement each other to provide more complete, accurate information for innumerable applications.

These, then, are the general benefits of color to image interpretation: reduced interpretation time, increased confidence, and image enhancement. All are oriented toward facilitating the detection phase of interpretation. But what of the analysis phase? What specific advantages can it offer there? A few significant benefits have been noted and are discussed in the following paragraphs.

1. Equipment counts are an essential part of many intelligence reports. Color proves to be an outstanding aid in this task, enabling the interpreter to determine not only the function of numerous objects, but also their operability, age, and general condition.

2. A detailed analysis of a target is incomplete without a determination of its structural content. From color structures of concrete, metal, wood, etc. are easily distinguished. Also, color provides more factual evidence and leaves less to assumption.

3. Color lends itself greatly to change detection, especially for areas in which new installations may be suspected. Freshly moved earth is readily apparent on color film but not on black-and-white film.

4. Color is crucial to the analysis of industrial targets. POL storage tanks and lines, chemical waste and smoke, and stockpiled minerals all have distinguishable hues, recordable only by this medium.

5. The testing of nuclear or chemical materials, whether above or below the earth's surface, will result in biological anomalies in the immediate environment. Most can be imaged only on CDIR (camouflage detection infrared) film.

6. Certain objects—possibly because of their structures, shadow patterns, or colors—seem to reveal more information on color film than on black-and-white. This is most evident in the analysis of ship imagery, where superstructure detail is sought.

7. Although both color and black-and-white film will image the same pattern of a given scene, color imagery of water and shoreline areas offers more information. The composition of the underlying material, beach trafficability, differentiation between rocks and vegetation, and general bottom detail are all enhanced significantly.

The resolution exhibited by most color imagery, however low, is sufficient to extract meaningful information from the majority of the selected target areas.

Films and Their Uses

The optimum application of CDIR film is in vegetated areas. Aside from delineating camouflage, CDIR film is an excellent indicator of stream patterns. The brackish water often found in small tributaries and marshes usually affects the chlorophyll balance of the surrounding vegetation. This images clearly on CDIR. Other features that are usually enhanced are trails. Hence, the film is useful for monitoring traffic patterns on land or water in densely vegetated regions.

In cultural areas, camouflage detection film is of negligible value. Its false color rendition, although at times enhancing, can lead to erroneous deductions. The principal reason for this is that CDIR film bleaches out earth colors and many of the hues characteristic of construction materials. The resultant image loses its enhancing effect and often fuses the color variations into obscure details.

Except for the above-mentioned situations (for which CDIR imagery can be collected at desirable scales) the use of normal color film will generally prove to be more advantageous. Furthermore, the well recognized ability of color to enhance shadow and underwater detail is most characteristic of unfiltered photography. The employment of minus-blue filters, such as the Wratten-12 used with CDIR, reduces or eliminates the ability to image detail in areas of bluish light–shadows or underwater.

Camouflage Detection Films

Kodak's special order Infrared Aero film, SO-180, is merely the older 8443 emulsion coated on a thinner base. Although the given resolution averages seem to indicate otherwise, sharper imagery is generally achieved with the new product.

Much exposed 8443 exhibits a bluish cast which almost totally nullifies the CD (camouflage detection) effect. This is often the result of incorrect exposure or improper storage. A difference in one f/stop is significant on either film. Proper storage of the material is essential. Unlike Aerial Ektachrome–which, although outdated, can still record some useful information–CDIR's value is totally lost when it is not used and stored properly.

Filters

A large number of filters exist, to reduce the effect of haze or to correct color balance. They are mostly of the haze or UV penetration type. Wratten Filters, Nos. HF-1 to HF-5, are recommended for haze penetration. Selection of the appropriate filter would depend on the severity of the haze. A tabulation of apparent haze filter requirements for the altitude range studied is presented in table 5-11.

At low altitudes, slight apparent differences exist when the imagery is unfiltered or moderately filtered. As might be expected, shadow and underwater detail are often clearer on the unfiltered photography. This leads to a tradeoff in the recording of port and shipping facilities. Usually, UV light is more highly concentrated in these areas and noticeably affects imagery. If a stronger filtration is used, some of the underwater detail will consequently be lost.

Other color distortions prove to be more easily correctable in printing when the original imagery is held to correctable limits; hence, color correcting filters are unnecessary. Only CDIR film remains a major problem; it is so sensitive to deviations in exposure that much of its value is often lost when it is used under less-than-ideal conditions.

Printing

Although at times a certain degree of color distortion is tolerable, the closer an image approaches color fidelity, the more valuable its information content will be. The problem of color bias, which is evident in almost any printed matter, is accentuated with hard-copy prints, because they combine loss of detail with loss of true color.

MISSION PLANNING

The use of color is actually simplified somewhat by the current state of the art. Color, because of its limitations, can only be regarded as a unique, special purpose sensor, which is used to augment black-and-white photography.

The benefits to be derived from color photography recommend it for the following applications:

1. Area search for unknown or unlocated targets.
2. Change detection, especially in areas where the construction of new sites is expected.
3. To exploit its ability to record indications of the structural content, condition, and operability of installations and equipment. Also, it can be used in equipment counts and for detailed analyses of military targets.
4. For the detailed analysis of certain industrial targets–such as chemical plants, stockpiled

Table 5-11.–Haze filter requirements.

Target area	Altitude range (in feet)	Atmospheric conditions	Desirable haze filter
Urban, industrial	Below 5,000	Arid	Light to intermediate
Port, shoreline	Below 5,000	Arid	Intermediate
Forested	Below 5,000	Arid	None to light
Mountains	Below 5,000	Arid	Intermediate
Plains, desert	Below 5,000	Arid	None to light
Urban, industrial	5,000-10,000	Arid	Intermediate to heavy
Port, shoreline	5,000-10,000	Arid	Intermediate to heavy
Forested	5,000-10,000	Arid	Intermediate
Mountains	5,000-10,000	Arid	Heavy
Plains-desert	5,000-10,000	Arid	Intermediate
Urban, industrial	Below 5,000	Humid	Intermediate
Port, shoreline	Below 5,000	Humid	Intermediate
Forested	Below 5,000	Humid	Light
Mountains	Below 5,000	Humid	Intermediate to heavy
Urban, industrial	5,000-10,000	Humid	Intermediate to heavy
Port, shoreline	5,000-10,000	Humid	Intermediate to heavy
Forested	5,000-10,000	Humid	Intermediate
Mountains	5,000-10,000	Humid	Heavy

NOTE: Light, intermediate, and heavy denote the use of an HF-1, HF-3, or HF-5 filter, respectively, or its equivalent.

minerals, nuclear power plants, etc.; color is of crucial importance in this area.

5. Where nuclear or biological testing is expected. CDIR sensing will often provide evidence to prove or disprove these occurrences.

6 To enchance beach, shoreline, and underwater detail.

7. Merchant and military shipping and port facilities.

8. To differentiate camouflaged targets from their surroundings. CDIR film is the only sensor specifically designed for this purpose.

9. To intensify shadow detail and partially hidden objects in any environment through normal color images.

Because of the prevalence of shadows in the early morning and late afternoon imagery, the unfiltered Ektachrome offered a bit more information at these times. Since sunlight shifts toward the red during these periods, no apparent color distortion results from the lack of an ultraviolet filter.

In view of its high sensitivity, CDIR film should be used discreetly. Relatively cloudless skies or total cloud cover seem to cause negligible exposure problems. More problems result from the presence of broken clouds, which often require frequent exposure changes or may cause variations within a single frame.

The greatest enemy of color photography is atmospheric haze. Although much of the haze is filtered out by the camera lens and UV filters, the emulsion's extreme sensitivity to it still produces noticeable degradation. CDIR has a slight edge on Aerial Ektachrome in "cutting" this haze, but neither can really do the job. Black-and-white photography with strong filtration is decidedly better than either. In essence, color is not recommended for conditions in which atmospheric haze is noticeable.

The selection of optimum configurations for using color should take a number of considerations into account; among them are:

1. The reason for using the material in the mission must be determined.

2. The film should be used in conjunction with black-and-white.

3. To be fully effective, color should be imaged at larger scales than black-and-white.

4. Because of its relatively slow processing, color can be used only in one or, at most, two stations of a reconnaissance vehicle in operational situations.

5. Color of the greatest information content has usually been recorded in vertical or near vertical attitudes. Because of atmospheric haze, high obliques and horizon to horizon panoramics are wasteful of its advantages.

6. Acquisition of small-target detail is possible only at scales of 1:6000 or larger with the available films.

In deciding upon color configurations, the mission planner faces the greatest difficulty with the RA-5C. Color is inadvisable in its high obliques, since filtration cannot effectively counteract atmospheric haze.

The choice, then, narrows down to the vertical or near-vertical cameras. Upon considering scale, the most advantageous configuration would seem to be color in the 12-inch focal length split verticals and black-and-white in the 6-inch focal length azvert. Tri-metrogen missions should only be attempted with the longer focal length azvert and the lowest obliques. The tri-vert, 6-inch configuration is useful at very low altitudes, if the consequent vignetting is deemed tolerable.

Film selection between normal color and CDIR film will also be contingent upon the sensor's desired function. If enhancement is the objective, either of the two will suffice. Camouflage detection, though, should be used with hesitation in cultural areas or in unfavorable weather.

A good rule of thumb is to use CDIR only for reconnaissance of vegetated areas.

SUMMARY

If the usage of color were increased now, the Navy would possess the required knowledge, as future developments arose, to be able to use the sensor to best advantage and color photography would play a major role in the design of future products.

The ability of color to facilitate detection, reveal essential target characteristics (e.g., structural, chemical, or mineral content; condition; operability), and differentiate natural and artificial features strongly recommends it for employment in area search for unknown targets; for reconnaissance of ports, shipping, and shoreline activities; and for detailed analysis of industrial and military installations.

The processing speed of the EH-73 presently limits its application to a more general usage. Computation of the true access times (i.e., time when the imagery is placed in the hands of the photographic interpreter) is difficult to determine in the absence of standard work flow and distribution procedures. If one can assume that the final product will be a positive, and that the original photography can be held on the ship for an indefinite time, the analysis in table 5-12 can be made.

From the preceding analyses it can be seen that with the premise that a positive transparency is the final product, the color photography is indeed competitive with black-and-white. If duplicates are required, this is not the case. Technological breakthroughs in processing speed, however, can be expected in the near future; they will serve to reduce the gap considerably.

The preceding point reveals the exigency of addressing the issue of work flow procedures. It is of utmost importance that no future obstacles be placed in the path of this sensor's exploitation. They would serve only to nullify color's advantages completely. The processor should be located, if at all possible, in the immediate proximity of the interpreter's working space. Presumably, this would be the IOIC (integrated operational intelligence center) on attack car-

Table 5-12.–Access times.

Operation	Time (minutes approx.)
Process 250 feet of black-and-white original negative at 12 fpm in EH-38	30
Print black-and-white original negative, using EN-90 printer at 100 fpm (including time for test)	10
Process the positive at 15 fpm	17
Prepare a black and white positive transparency of 250 feet in length (total time)	60
Process 250 feet of color reversal film in the EH-73 at 5.4 fpm	47

riers. For these ships, the option of installing the instrument in the photographic laboratory will generate needless time expenditure in operations and compromise water-tight security because of its required ventilation system. Another obstacle to effective utilization would be burdening the processing personnel with a demand for hard-copy prints of select color imagery. Of the photographic color papers presently available, none is compatible with EH-73 chemistry. If chemistry changes are constantly required during operations in response to demands for paper prints, system costs will soar, and more useful operations will suffer. Production printing of hard-copy material is inadvisable until a compatible color printing paper has been developed.

The employment of color in strike photography generally results in improved imagery, permitting more rapid detection and assessment of tactical targets.

Color photography is not recommended for use in the stereometric-comparison-viewer. This viewer's illumination system does not image the material to its best advantage. Direct viewing is definitely the optimum technique for data extraction from this sensor.

Throughout this section, color has been regarded as a limited, special-purpose sensor. This is not an attempt to demean its unique capabilities. By introducing an automatic color processor into the operational sphere, the Navy is, in effect, exploiting a significant intelligence gathering medium. Regarding it as "special-purpose" is only meant to signify that now or in the near future it is not likely to usurp the role of black-and-white photography in multisensor reconnaissance. However, like infrared, side-looking radar, and other special-purpose sensors, color imaging can often prove itself as the optimum for a variety of applications.

CHAPTER 6

PHOTOGRAPHIC QUALITY ASSURANCE

Quality assurance in photography has one purpose—to assure that the photography produced is of constantly high quality, whether it be a negative, print, transparency, or any other form. The quality of the product is determined by three factors, each having many variables. These factors are human (or personnel), chemical, and mechanical. The human factor includes those personnel involved in the photographic mission and planning, photographic development and/or printing, as well as those photographers who work directly in the quality assurance section of a photographic laboratory. Chemical factors include all of the chemicals and solutions used to process and print original negatives, positives (viewing and intermediate), duplicate negatives, and prints. Mechanical factors include all equipment used to expose film, plus the equipment used to develop and/or print exposed film with subsequent reproductions.

Quality assurance can be applied to either a portion of the system or to the entire system. In quality assurance there are three basic steps, as follows:

1. The quality standards for the process must be specified.
2. The process must be evaluated to insure that the standards of quality are being maintained.
3. Any cause for poor or substandard quality must be identified and eliminated from the photographic procedures.

Chemical and sensitometric means are used in determining if the standards of quality are being sustained.

Detailed quality assurance applied to the photographic process will assure the photographer of a better product if defects are spotted as early as possible. If a defective film holder is allowing light to fog the film, the defect should be discovered after the negative is processed (if not sooner). Certainly it would be a waste of time and material to make prints from such a negative if the photograph had to be reshot. It is the purpose of this chapter to explain some of the many quality assurance procedures which can be applied as an aid to betterment of the product.

SENSITOMETRY

Up to this point in the discussion of quality assurance, only the visual aspect has been considered. As a further step, one should have a knowledge of other controlled working methods and techniques. Slipshod methods will occasionally produce good photographs, but the serious photographer should not be satisfied with "sometimes" results when there are techniques and equipment available to aid in arriving at the goal of uniformly good photographic production.

This area of control in photography is known as sensitometry. It is a method of putting certain photographic theories to work to improve photographs while saving time, effort, and materials. Sensitometric methods, coupled with chemical and statistical controls, will have an end result of a tremendous increase in photographic quality.

Another term used in conjunction with sensitometry is densitometry. Densitometry is an integral part of sensitometry, being so closely tied in with it that the two terms are often used together or interchangeably. Technically, however, there is a difference between them, which is as follows:

1. Sensitometry is the science of determining the photographic characteristics of light-sensitive materials.

2. Densitometry is the measuring method by which data are obtained for sensitometric calculation purposes.

In order to understand sensitometry, it is necessary to become somewhat acquainted with the mathematics of logarithms, since many of the values discussed in sensitometry are expressed in logarithmic terms. Also, sensitometric curves are commonly constructed using logarithmic values as a basis. Additionally, the understanding of sensitometry requires a greater insight into three sensitometric terms–transmission, opacity, and density.

COMMON LOGARITHMS

Photographers have been making photographs for many years using standards that were established by trial and error methods. Now, however, it is known that there are definite mathematical relationships between the processes used in photography and that these relationships can be used to produce the maximum results needed. Before the photographer is able to use these relationships in quality assurance, he must have an understanding of common logarithms so that he will be able to understand and determine the proper data used in this field.

Logarithms are used by the Photographer's Mate in determining density, plotting characteristic curves, determining gamma, determining log E, the use of densitometers, the production of positive viewing transparencies, and generally in any lab which has a quality assurance setup.

By means of logarithms, a mathematical function is used to calculate complex problems with speed and accuracy. A logarithm is an exponent to a base number and is the power to which the base number, usually 10, must be raised to equal a given number. In photography we work with common logs, which are logs to a base 10. The base 10 is used, because our numerical system is based on units of 10 and calculations can be made easier by the use of "powers of ten." For example, the logarithm of 100 is 2, because 10^2 equals 10 times 10 or 100. The logarithm of 1,000 is 3, because 10^3 equals 10 times 10 times 10 or 1,000.

One of the main uses of logarithms in photographs is in reducing to a manageable form the characteristic curve of the film. The characteristic curve indicates how increasing the exposure in a series of steps will affect the emulsion. Each step in the series represents a constant multiple of the value of the previous step. For example, exposure units could be in a series of steps such as 1, 10, 100, 1,000, 10,000, 100,000, etc. Notice that this is only six steps, each step being a constant multiple of 10. Equal importance could not be given the first and last steps if the curve were plotted without logarithms. If instead of using the numbers we used their logarithms, the effect would be to give every step from the highest to the lowest values the same amount of spacing along the exposure axis.

The Photographer's Mate should refer to chapter 8 of Mathematics, Vol. 1, NavPers 10069-C, for a review and/or explanation of the principles and procedures of common logarithms before proceeding with this chapter.

TRANSMISSION, OPACITY, AND DENSITY

The various qualities of light were covered in Photographer's Mate 3 and 2, NavPers 10355-A, chapter 3. However, from among these qualities the senior Photographer's Mate needs a greater insight into the sensitometrically important terms of transmission, opacity, and density.

TRANSMISSION

Most photographic materials, even clear film, do not transmit or pass all the light rays that are incident to them. Transmission is a measure of the light-passing ability of a film or other medium. When speaking of the transmission of a processed film, what is meant is the fraction or percentage of incident light that passes through the film. In a formula, transmission is denoted by a capital T. The formula for determination of transmission is as follows:

$$T = \frac{\text{Amount of transmitted light}}{\text{Amount of incident light}}$$

The result will never be more than 1/1 or 1.00. For example, if 10 meter-candles (m-c) of light are incident or falling on a film and 5 m-c are passing through it, the transmission is: T = 5/10, or T = 0.50, or 50 percent. If 2 m-c are transmitted, the formula will read T = 2/10, or 0.20, or T = 20 percent.

OPACITY

Opacity is a term given to the measure of the ability of the medium to absorb light. Inasmuch as the two terms transmission and opacity are directly opposite in meaning, the figures used to indicate them are also directly opposite to each other. The opacity is indicated in a formula by the capital letter O and is the reciprocal of the transmission. The formula for opacity is given as

$$O = \frac{\text{Amount of incident light}}{\text{Amount of transmitted light}}$$

It can be seen that it is the transmission formula turned upside down. Again, if a material has 10 m-c of light falling on it and 5 m-c are being transmitted, one may figure the opacity by the formula O = 10/5 or 2. Putting it a different way, opacity is the reciprocal of transmission, or O = 1/0.50 = 2. Or, if 2 m-c are being transmitted, the formula is O = 1/0.20, or O = 10/2; in either case, the opacity is 5.

DENSITY

In formulas, density is indicated by the letter D, and it is merely another way of expressing opacity, or the light-stopping ability of a medium. For the purpose of simplicity and evenness of progression, it is convenient to use the common logarithm of opacity for expressing the light-stopping ability.

It can be noted here that of the three terms used in this chapter, i.e., density, opacity, and transmission, the one with which the photographer is the most concerned is density. However, no one of the terms can be disassociated from the others, and each one of them is dependent on and directly related to both of the others. If the value of any one of these factors is known, with a little time spent in computations one may calculate the others. Many times the photographer will be called on to do just this. One may measure the transmission of a film and then desire to know its density. Or conversely, one might measure the density and need to know the amount of transmission. While charts are available to give some conversions directly, it is well to be able to determine any of those figures.

SENSITOMETERS

Photographic sensitometry refers to the measurement and study of the sensitivity of photographic materials. Sensitized materials form the basis for all photographic production. Photography usually deals with light-sensitive materials–that is, materials sensitive to the visible portion of the spectrum. In this sense, then, one may define exposure as being the subjecting of a light-sensitive material to a light intensity for a given period of time. Sensitometric-densitometric testing requires a method of comparing the amount of exposure given to an emulsion to the amount of density which results from that exposure.

Densitometers are covered later. As their name implies, they are the instruments used for measuring densities. Sensitometers are designed for the purpose of making controlled exposures which will produce the densities suitable for sensitometric-densitometric testing procedures.

CONTROLLING EXPOSURE

For testing purposes one must have some method of controlling the exposure so that a known amount and quality of light can be had. Ideally, light should be controlled in such a manner that one can do the following:

1. Predetermine the total amount of exposure.
2. Determine the difference among exposures given to various areas.
3. Control the color quality of the light.
4. Consistently reproduce (duplicate) the same light conditions.
5. Obtain a wide enough range of exposures to produce densities ranging from light to very heavy.

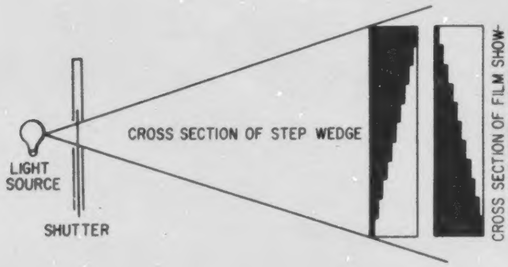
Nearly any normal scene that might be photographed includes a wide range of brightness values which are represented on a negative as areas receiving varying amounts of exposure. However, these different brightnesses are scattered throughout the picture area and are difficult to measure. For the sake of simplicity, uniformity, and reproducibility in the application of sensitometry, these exposures are arranged in a series of gradually increasing steps that correspond to the relative brightness values of a normal scene.

One of the first requirements for any type of sensitometric control is a sample of the sensitive material that has been properly exposed under measurable and reproducible conditions. For test purposes, it is customary to expose a strip of film so that several exposures are made on the same strip. The instrument used to make a series of controlled exposures on a sensitive material is known as a sensitometer.

Figure 6-1 shows in simple form the principle of the basic type of sensitometer discussed in this chapter.

THE SENSITOMETRIC STRIP

The sensitometric strip (sometimes called a control strip or test strip) is a convenient method of producing a uniform, measurable set of densities for test purposes. These densities should progress by some predetermined multiple of exposure and should have sufficient range so that they will be representative of any densities likely to be encountered in a photographic negative. The most convenient way to produce sensitometric strips is to print them on a sensitometer.


CROSS SECTION OF STEP WEDGE
LIGHT SOURCE
SHUTTER
CROSS SECTION OF FILM SHOWING VARIOUS DENSITIES

PH.396

Figure 6-1.—Intensity-scale sensitometer.

Exposure of the Test Strip

Photographic exposure is defined as the product of illumination and time. The unit of exposure is the meter-candle-second (m-c-s), which means the exposure produced by a light source of 1 candlepower, in 1 second, at a distance of 1 meter from the surface of the light-sensitive material. It follows, then, that the two important parts of a sensitometer are its light source and the device for producing the series of exposure steps.

Light source lamps for a sensitometer must be carefully chosen, and their characteristics must be precisely known. The intensity of the light must also be known. It must be sufficient to make the time of exposure correspond closely with actual photographic practice, and it must remain constant over long periods of time. In addition to this, it is of utmost importance that the spectral composition (color temperature) be known, that it be constant, and that it corresponds closely to the quality of light likely to be used in practical photography. The reason for this is the fact that the material should be tested under conditions as closely allied as possible to those which will occur in practical use. There would be little purpose in knowing an emulsion's reponse characteristics under conditions which would never be encountered. By basing sensitivity measurement on a known, practical basis, the film's response under practical conditions will be known, and various films may be compared to each other as to their spectral sensitivity and comparative speed. It is a known fact that emulsions often change in apparent sensitivity (speed) with a change in the spectral composition.

The illumination requirements described above are fulfilled most completely at the present time by special incandescent tungsten lamps Both the intensity and the color quality of a lamp of this kind depend on the current flowing through the filament. It is necessary to maintain the proper voltage at all times. Another factor in precision sensitometry is the change in both intensity and color with the age of the lamp. For this reason, a replacement lamp should be burned for a short time before using it for testing purposes. The old lamp should be discarded before any appreciable change occurs.

Incandescent lamps of the type most suitable for use as a standard light source operate at a color temperature of about 3200 K. The color temperature of sunlight at the earth's surface has been fixed by general agreement at 5400 K. Therefore, the use of a filter is necessary to alter the spectral energy of the lamp so that it is equivalent to the spectral energy of sunlight. At the Seventh International Congress of Photography in 1928, a resolution was passed adopting a tungsten filament vacuum lamp fed by direct current, operating at a color temperature of 2360 K and a liquid filter proposed by Davis and Gibson of the U.S. Bureau of Standards as a standard source for photographic sensitometry.

Gelatin filters, such as the Wratten 78, 78A, and 79, however, are much more convenient, and since they duplicate the liquid filter with sufficient accuracy for most practical purposes, they are generally used.

Exposure intervals for a sensitometer are used to produce a graded series of exposures, the values of which are accurately known. These are generally arranged in steps increasing in order from low to high exposure. A part of the strip is left unexposed in order that the fog density of the material itself may be determined.

The device or method used as an exposure modulator must also meet certain requirements. It should be able to produce an exposure range that conforms closely to that found in actual practice, be of sufficient accuracy, be consistent, and have no significant effect on the color quality of the light.

Inasmuch as total exposure is the result of the intensity of the illumination and the length of time it is allowed to act, it is obvious that the exposure may be varied by changing either the intensity or the time.

Sensitometers are accordingly grouped into two classes. If the intensity of the light is changed while the time is the same for all the steps, the sensitometer is known as an intensity-scale instrument. If the time is varied while the intensity is kept constant, the instrument is a time-scale sensitometer.

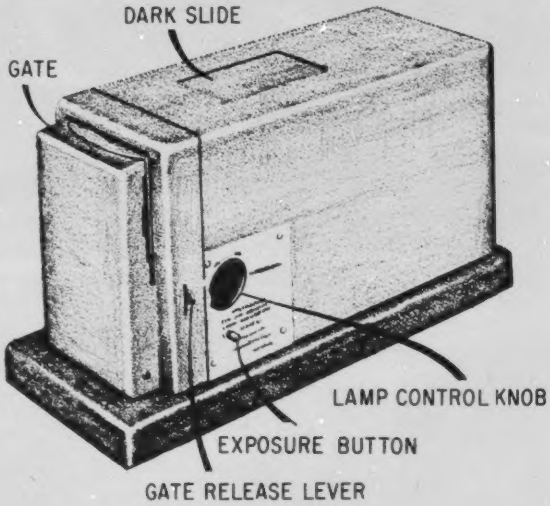
INTENSITY-SCALE SENSITOMETERS

Sensitometers in which the scale of exposures is produced by varying the intensity of the illumination on different parts of the emulsion are theoretically preferable to time-scale instruments because, in actual practice, photographic materials are usually exposed to differences in illumination. For example, exposing negative material in the camera subjects the emulsion to varying intensities rather than to differences in time. Many types of sensitometers producing illumination scales have been designed, but those using light absorbing filters, commonly known as step wedges, are the most widely used.

Kodak Model 60

The Eastman Kodak Processing Control Sensitometer Model 60 (fig. 6-2) is an intensity-scale sensitometer designed for rapid and convenient production of reproducible exposures on black-and-white or color films. The Model 60 is for use with 115-volt, 60-cycle alternating current and contains a voltage regulator mounted on the base inside of the housing of the sensitometer.

A shutter disk directly connected to a synchronous motor provides a fixed exposure time of 1/10 of a second. A calibrated projection lamp provides illumination of constant intensity and color quality. Combinations of calibrated neutral density and color balancing filters are used in the exposing beam to convert the illumination



PH.397

Figure 6-2.—Eastman Kodak Model 60 Sensitometer.

intensity and color quality to meet the requirements of the material to be exposed. The electrical circuit for the lamp consists of a voltage regulator to supply constant voltage, a variable transformer to produce the correct lamp current, and an ammeter to set and read the required lamp current.

The film is held by a pressure pad against a step wedge during exposure. The step wedge furnished with the Model 60 has 21 steps with 0.15 density increments between steps. The density range is approximately 0.05 to 3.05.

OPERATIONAL NOTES.—The calibration life of the lamp is 100 to 150 hours. To conserve this, do not operate the lamp at a current value greater than specified on the calibration tag, and turn the instrument off when not in use. To protect the lamp and ammeter from sudden current surges, always turn the instrument on and off with the lamp control knob, not by inserting and pulling out the power cord in the outlet.

When placing filmstrips on the pressure pad, be sure the emulsion side faces the lamp. The filmstrips must be at least 6 1/2 inches long for ease in handling; however, they should be cut longer if the film is to be spliced onto a roll for machine processing. Figure 6-3 shows a filmstrip in position on the pressure pad prior to closing the gate.

A neutral density filter assembly having a density of 1.2 is provided with the instrument. Sliding this filter into the exposing beam reduces the illumination to a level suitable for faster film speeds. The color filter holder (fig. 6-4) accepts the 3-inch square filters needed to balance the color quality of the illumination for the various color films. The Kodak Color Temperature Conversion Filter No. 309, supplied with the sensitometer, is used to correct the color temperature of the lamp to daylight quality illumination.

Consult the manufacturer's instruction manual for the operation and maintenance of this instrument. The Eastman Kodak Model 101 Sensitometer is similar to the Model 60, except that the shutter speed is 1/5 of a second instead of 1/10 of a second.

Processing Sensitometric Strips

The processing of the sensitometric strips must be done under controlled conditions of time, temperature, and agitation. Ideally, they should be processed under the same conditions

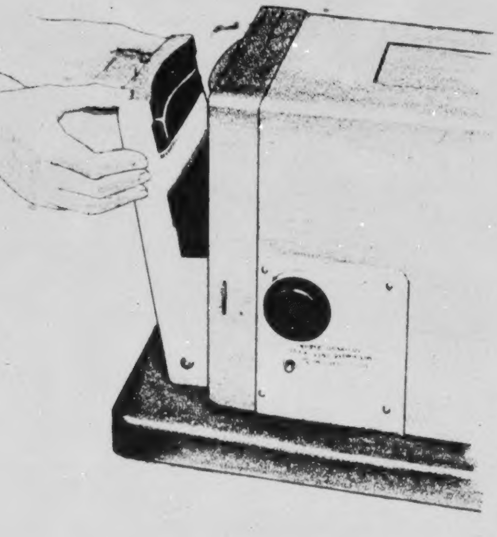


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Figure 6-3.—Placing filmstrip in position.

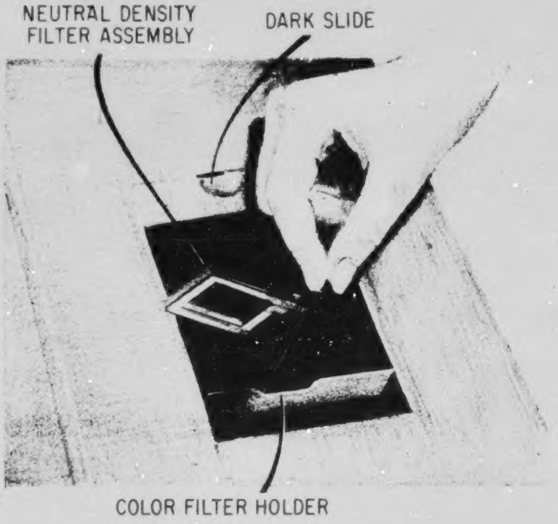

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Figure 6-4.—Inserting filters.

as the photographic laboratory uses in the processing of their normal production negatives. This holds true whether the material is black-and-white stills, motion pictures, aerial, or color.

The density obtained in a developed image depends on the characteristics of the emulsion, the exposure it has received, and the degree of development. With any given emulsion, the degree of development depends on (1) the temperature of the developer, (2) the length of time the developer is allowed to act, (3) the degree of agitation of the film or the developer, and (4) the activity or energy of the developer, which is determined by the composition of the solution and the degree of exhaustion.

1. Temperature of the developer. The rate of development is directly affected by the temperature of the solution. As the temperature rises, the solution becomes more active, and the rate of development increases. Conversely, when the temperature is low, the developer reaction is slow and the rate of development decreases. Within limits, these changes in temperature can be compensated for by increasing or decreasing developing time.

Besides the changes in development rate, there are other effects of the temperature of the developer. At high temperatures, the gelatin emulsion becomes so soft and swollen that it may easily be damaged, or might even loosen from the film base. At low temperatures, the solution loses energy and can even become inactive. Hydroquinone, for example, loses a great deal of activity at low temperatures.

2. Time of development. When the exposed material is placed in the developer, the solution penetrates the emulsion and begins to reduce the exposed silver salts to metallic silver. The longer the development is carried on, the more the silver is formed and the denser the image becomes. Development also progressively increases the contrast, up to a point; then it begins to fall off. Up to that point, the longer the material is allowed to develop, the higher the degree of contrast.

3. Agitation. If exposed films are placed in the developing solution and allowed to remain without any movement, that part of the solution that is in the emulsion or in contact with its surface soon becomes exhausted and ceases to work. If either the film or the solution is agitated, or moved, fresh portions of the developer are brought into use, and the rate of development becomes more constant. Agitation has a far more important effect on the degree of development than is generally realized. Another important reason for agitation is the prevention of uneven development. If there is no agitation, the exhausted solution (loaded with by products from the emulsion and developing agents) may flow across the surface of the film from the denser areas to produce uneven streaks and spots.

4. Activity of the developer. The rate of development is naturally affected by the chemical activity of the solution. This depends on the composition of the developer, on the nature and dilution of the solution, and upon its effective alkalinity. In addition, the activity of the developer decreases with use, partly because of the destruction of the developing agent in changing the exposed silver salts to metallic silver, but mainly because of the restraining action of the accumulated bromide resulting from the development.

Since these four factors have such an influence on the rate and amount of development, it becomes necessary, for testing purposes, to have enough control over the processing facilities and techniques to enable the photographer to reproduce, or duplicate exactly, all conditions each time he processes. Obviously, if it is necessary to know what a certain kind of film will do under a certain set of conditions, tests made under any other conditions will be of no value. Although the techniques used for processing are important, it is more important that development standards be reproducible. A method should be devised whereby all factors remain constant and the processing accomplished exactly the same every time. This means using the same kind and amount of developer, the same dilution, the same temperature, agitating in the same manner and at the same rate, and even using the same timer and thermometer. In other words, everything must be exactly the same.

TANK PROCESSING OF TEST CONTROL STRIPS.–Test control strips should be processed when possible under the same conditions as the production film, and under controlled conditions of time, temperature, and agitation. The control strip after being printed can be attached to either a roll of film or leader. In this event the strip goes through the processing machine tanks with the rest of the roll and receives the same processing. It should be kept in mind that all steps in the processing of control strips and film are important, if the process is to maintain high standards and uniformity of results. Each step in the entire process must be carried out as carefully and as systematically as possible, with a uniformity in times and handling techniques in each step from the exposure to the drying of the processed film.

DENSITOMETERS

A densitometer is an instrument for measuring and reading directly (in terms of density) the light-stopping ability of areas of negatives or prints. Densitometry is the practical application of sensitometry. Sensitometry (measuring sensitivity) is the determination of the photographic characteristics of light-sensitive emulsions. Densitometry (measuring density) involves the use of densitometers for obtaining the data with which to make the necessary calibrations for determining these characteristics.

Densitometers are used in quality assurance to read densities so that characteristic curves can be plotted, to aid in the production of color prints, to aid in the continuous strip printing of positive films and duplicate negatives, and in aerial and motion picture photography. Certain types of densitometers read transmitted light, while others read reflected light. There are two main types of densitometers, the comparison type of meter and the direct reading type meter. The comparison type meter is further divided into two types, visual and electronic.

COMPARISON TYPE DENSITOMETERS

A comparison type of densitometer compares an unknown sample with an established standard, to indicate the amount and direction of variation between the unknown sample and the established standard.

Visual

Visual type comparison densitometers are simple in design and relatively economical. However, they do have some distinct disadvantages. One of the main disadvantages is the possibility of erroneous measurements, due to the fallibility of the eye. The visual type meter depends upon visual judgment and estimates of brightness. Using the meter for long periods of time usually results in eye fatigue, and as a result, erroneous readings are sometimes obtained.

Another disadvantage is the dependency of visual meters upon the calibration of step wedges for their accuracy. These step wedges, which are used as standards, will change in time with age and use, resulting in erroneous readings.

Electronic

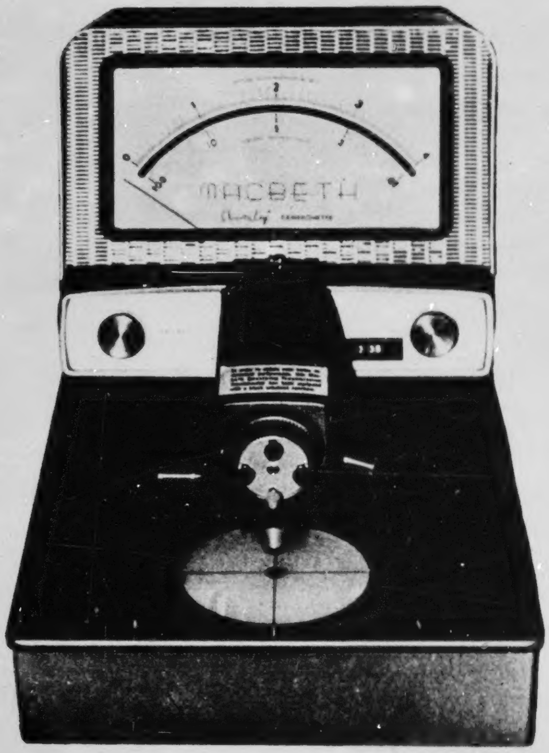
Electronic type comparison meters are very fast and dependable for constant readings. Examples of this type of densitometer are the Densichron 20, PTM-8, and the Macbeth QuantaLog EP-1000.

The electronic type comparison meter is used mainly as an "on easel" evaluation instrument in color printing.

DIRECT READING DENSITOMETERS

Photoelectric, direct reading densitometers are the second type of meters. They depend upon a photoelectric cell to electronically measure the light transmitted through a sample of the material. To use the meter, the operator places the material to be measured in the light beam between the source and the photocell. The density value is then read directly from the meter dial. Examples of direct reading or photoelectric densitometers are the Weston Analyzer, Densichron No. 1 and 2, and the Macbeth QuantaLog TD-102 illustrated in figure 6-5.

The Macbeth Quantalog TD-102 is a single unit transmission densitometer, having all its components located in a single cabinet. The meter is equipped with four selectable filters for color and visual density measurements with a range of 0 to 4.0 density units. A calibrated light source located at the bottom of the cabinet is



PH.400

Figure 6-5.—Macbeth Quantalog TD-102 Densitometer.

supplied with three sizes of circular apertures to control the diameter of the beam of light allowed to pass through the sample being measured. The size of the area from which the reading is desired determines the diameter of the light beam to be used.

The 1/2-mm (0.028-inch) aperture for the TD-102 is highly recommended for use in the determination of proper tone reproduction exposures. The linear meter scale has evenly spaced graduations and a mirrored meter scale. This minimizes possible operator error and enables him to make accurate and reproducible meter readings, since parallax errors are avoided.

TD-102 Components

Components of the TD-102 discussed in the following paragraphs include the collector head (snout), the filter trim controls, the zero adjust control, and the calibration control.

COLLECTOR HEAD.—Light transmitted through the sample being measured is received by the collector head and projected to the photoelectric cell above the snout, creating a voltage proportional to the intensity of the light. This voltage generates a signal which, when sent to the meter amplifier, causes the meter needle to move. The amount of movement indicates the density value of the sample. The throat clearance of the collector head is 13 inches; this enables the operator to read the center of samples up to 22 inches wide and of any length.

FILTER TRIM CONTROLS.—Separate mechanical trimming controls enable precise individual zeroing of each of the four selectable filters contained in the densitometer's filter turret. These controls are a gold knob for the Wratten #106 (gold) filter; a red knob for the Wratten #92 (red) filter; a green knob for the Wratten #93 (green) filter; and a blue knob for the Wratten #94 (blue) filter. The red, green, and blue filters are used in color evaluation.

ZERO ADJUST CONTROL.—This is a dual purpose control, containing the on-off switch that controls the supply of power to the equipment and the zero adjust by which the needle is adjusted to the zero position whenever the meter is being calibrated.

CALIBRATION CONTROL.—This control corrects the meter to read a specific up-scale reading to which the densitometer has been calibrated. The TD-102 is accurate to plus or minus 0.02 density units and reliable readings can be made with a repeatability of plus or minus 0.01 density units.

TD-102 Operating Procedures

The TD-102 is designed for operation under all normal conditions of ambient illumination. Operating the meter either by a sunlit window or in a darkroom will not affect its performance. The meter scale, however, is not illuminated; therefore, some type of illumination is required to read the scale.

A 30-minute warmup period should be allowed to permit optical components, such as color filters, to arrive at thermal equilibrium. A slight drift may be encountered after the light source has been turned on; this is due to the thermal lag of the filament and other light source components. The TD-102 is a manually operated and manually calibrated instrument. Therefore, it is recommended that the ZERO ADJUST and CALIBRATION control settings be checked often during operation, and reset whenever necessary to insure that the meter will perform according to specifications.

The emulsion side of the sample should face upward, toward the collection cone, whenever density measurements are to be taken. Detailed operating instructions for the Macbeth TD-102 Densitometer is given in the manufacturer's handbook and NavAir 10-1-792, Photographic Processing Standards Manual, Integrated Operational Intelligence Center.

PLOTTING CHARACTERISTICS CURVES

For plotting a characteristic curve it is best to use graph paper ruled 20 units to the inch or 20 units per 1/2 inch. The horizontal axis of the graph is used to indicate log exposure, increasing from left to right, and the vertical axis is labeled in density, increasing upward.

Figure 6-6 is a reproduction of the plotting sheet used by NATTU, Pensacola. A graphic scale has been included in the illustration so that operating units may reproduce the plotting sheet at its original scale. Use of this plot sheet eliminates the time-consuming task of marking off step wedges.

When labeling the graph paper remember that a 0.30 in density is a doubling value. Therefore, use 15 small divisions on the graph equal to a doubling of density and log exposure. If the sensitometric strip is made with the Eastman Kodak #2 Step Wedge, as supplied with the Eastman Kodak Model 60 sensitometer, there is an increase of about 0.15 in density between each step. The individual steps should be calibrated either by reading the step on a densitometer or, preferably, by having the Eastman Kodak Company supply a certificate of calibration for the step wedge supplied with the Model 60 sensitometer. The total density range of these steps is usually quite close to the 0.1-3.1 density specified, but the individual steps often vary about their nominal values. Therefore, to label the exposure steps on the graph let each 7.5 division equal each step of exposure increase of the sensitometric strip. It should be noted that another advantage of having a calibrated step wedge is that the operation of the Welsh Densichron can be monitored to make sure that the instrument readings are not seriously in error.

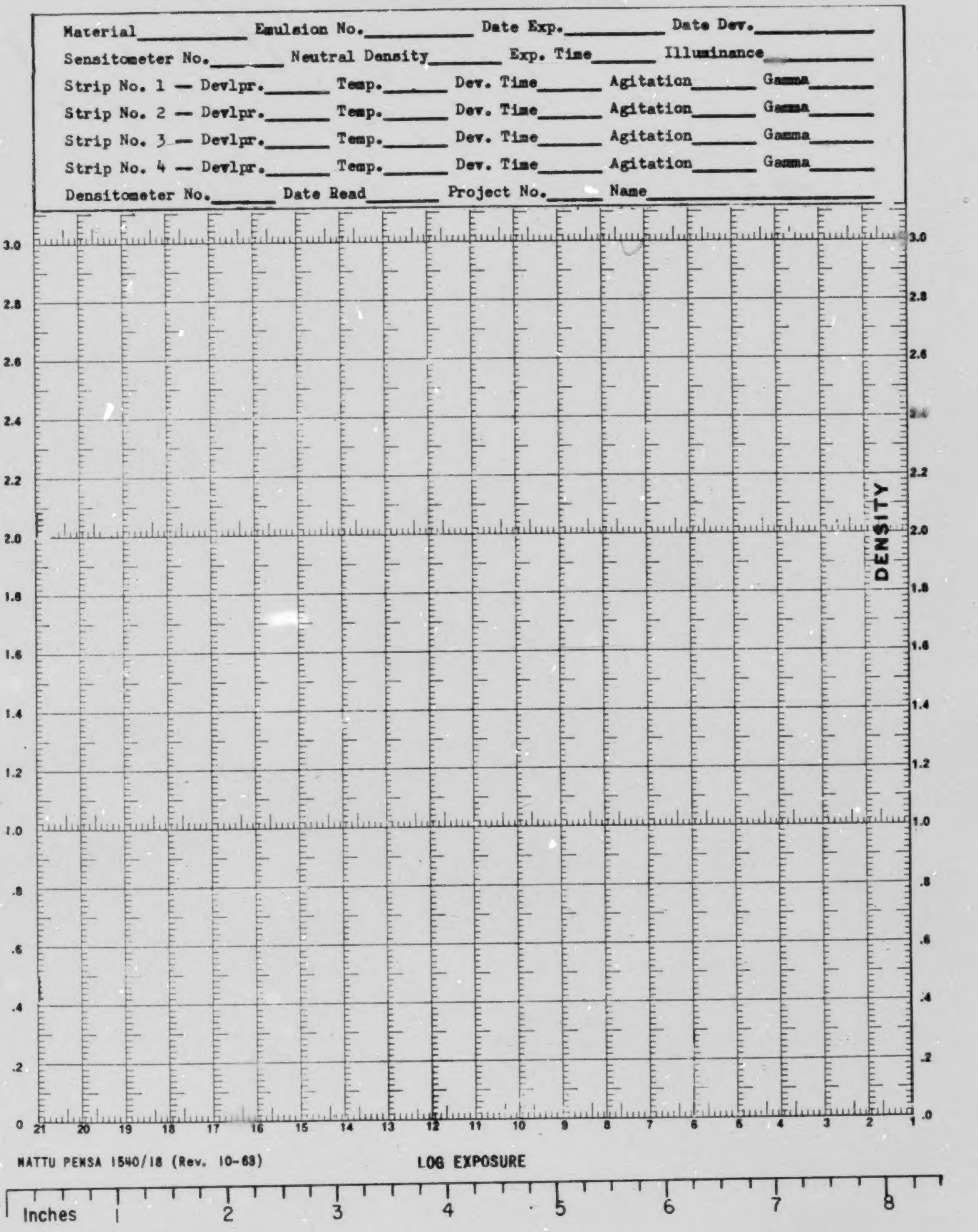
Once the graph is labeled, read the densities of the sensitometric strip and plot them on the curve. Assume that the sensitometric strip has the following density readings:

Step	Density
1	1.82
2	1.78
3	1.70
4	1.60
5	1.50
6	1.40
7	1.30
8	1.20
9	1.10
10	0.99
11	0.90
12	0.79
13	0.70
14	0.59
15	0.49
16	0.40
17	0.32
18	0.26
19	0.21
20	0.19
21	0.18

Base + fog 0.12

To record these densities on the graph, start with the lowest density reading and place a dot at the convergence of that density and step No. 21. (See fig. 6-7.) Do the same with the remaining steps 20 through 1 as illustrated in figure 6-7. After plotting all the readings, connect the plotted points with a french curve and straightedge. Insure that the curve is a smooth flowing line with no angles apparent.

Every graph should be labeled with all pertinent information, since all characteristic curves are similar in appearance. Information which is



Material________ Emulsion No.________ Date Exp.________ Date Dev.________

Sensitometer No.______ Neutral Density______ Exp. Time______ Illuminance________

Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Densitometer No.______ Date Read______ Project No.______ Name______________

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DENSITY
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
LOG EXPOSURE
Inches
1
2
3
4
5
6
7
8

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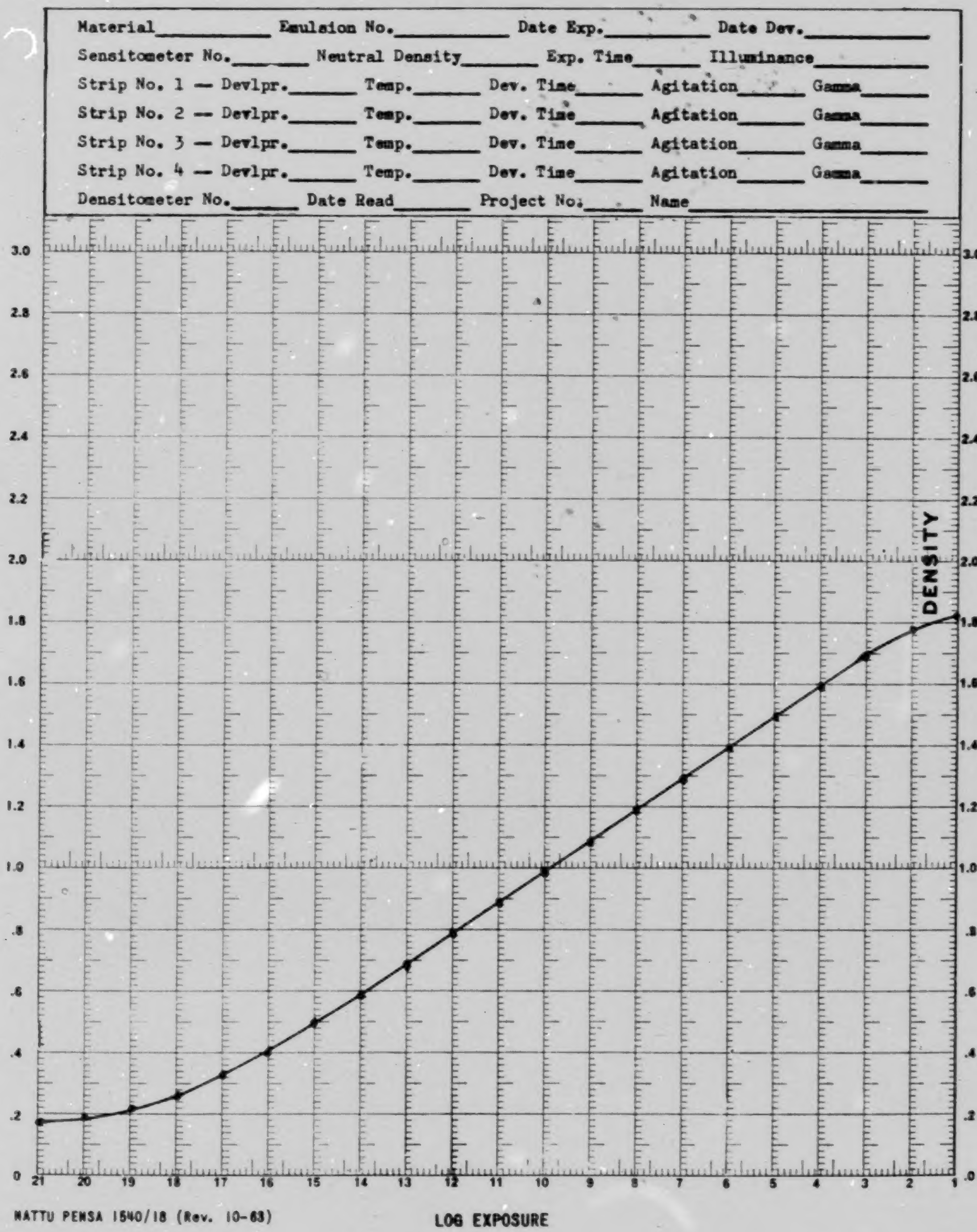
Figure 6-6.—Plotting sheet.



Material__________ Emulsion No.__________ Date Exp.__________ Date Dev.__________

Sensitometer No.________ Neutral Density________ Exp. Time______ Illuminance__________

Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Densitometer No.______ Date Read______ Project No.______ Name__________________

PH.402

Figure 6-7.—Plotting a characteristic curve.

not recorded on the graph may be lost or forgotten, and the graph becomes useless.

ANALYZING CHARACTERISTIC CURVES

The main function of sensitometry is to measure, record, and represent graphically the reaction of light-sensitive emulsions to varying conditions of exposure and development and to analyze and interpret results. Thus, it is possible to determine the effective speed of the emulsion, its contrast, and its latitude and useful exposure range. Also, the analysis of sensitometric curves provides the basis from which all sensitometric determinations emerge. Figure 6-8 illustrates a typical characteristic curve showing the various parts and their names.

Density standards are established by using sensitometric equipment and techniques to prepare graphs representing sensitometric data. Characteristic curves, also referred to as H and D curves, D log E curves, or response curves, are plots of density versus log exposure. If this curve is prepared on a standard form (fig. 6-6), it is also referred to as a sensitometric chart. The speed of the material being evaluated determines the position of the curve in relation to the log E axis. The length and slope of the straight line portion are the main variations to the shape of the curves. All densities on the straight line portion of the D log E curve are increased proportionally with an increase in development time. The slope (gradient) of the straight line portion of the curve also increases as the development time is increased.

HORIZONTAL AXIS

A logarithmic scale of exposures is used for the horizontal axis because it gives correct representation of exposure changes.

VERTICAL AXIS

A logarithmic scale is used for the vertical axis because it correctly represents the amount of silver formed in the negative. Remember that density is the log of opacity. Theory indicates and measurement proves that density is directly proportional to the amount of absorbing material that is present in a given area.

Notice in figure 6-8 that the first two steps show a slight and equal amount of density. This indicates that this area of the film has not been affected by the light, and the density is due only to the emulsion base and to the fog base which is present to a certain extent in all emulsions. On the third step, a slight increase in density is shown. This is called the threshold and indicates the least amount of light that is required to produce a density which is perceptible. Exposures in this portion of the curve lack shadow detail.

TOE SECTION

The threshold is the beginning of the toe portion of the curve. The toe is a concave, rising portion that gradually increases in density. This section is defined as a region of unequal rise, because the density does not increase equally for equal increases in exposure. Any subject tones exposed here will be reproduced with small, unequal density differences. These differences increase toward the right in the toe. At one time it was felt that this region of the curve was to be avoided. It is now known that satisfactory exposures can be made with the shadow portion of the subject falling not too far down in the toe area.

STRAIGHT LINE PORTION

Farther to the right is a section of the curve which appears to approximate a straight line. (In many cases there is no well-defined straight line.) This part of the curve has a constant slope, and in addition, the slope here is greater than in any other part of the curve. The straight line portion indicates there is a corresponding and equal increase in density for equal exposure increases. This is the most important part of the curve because it represents the area of proportional brightness representation or correct exposure. Exposures arranged so that the subject tones fall on the straight line will produce constant maximum density differences.

INERTIA

If the straight line portion of the characteristic curve is extended to intersect the log E axis,

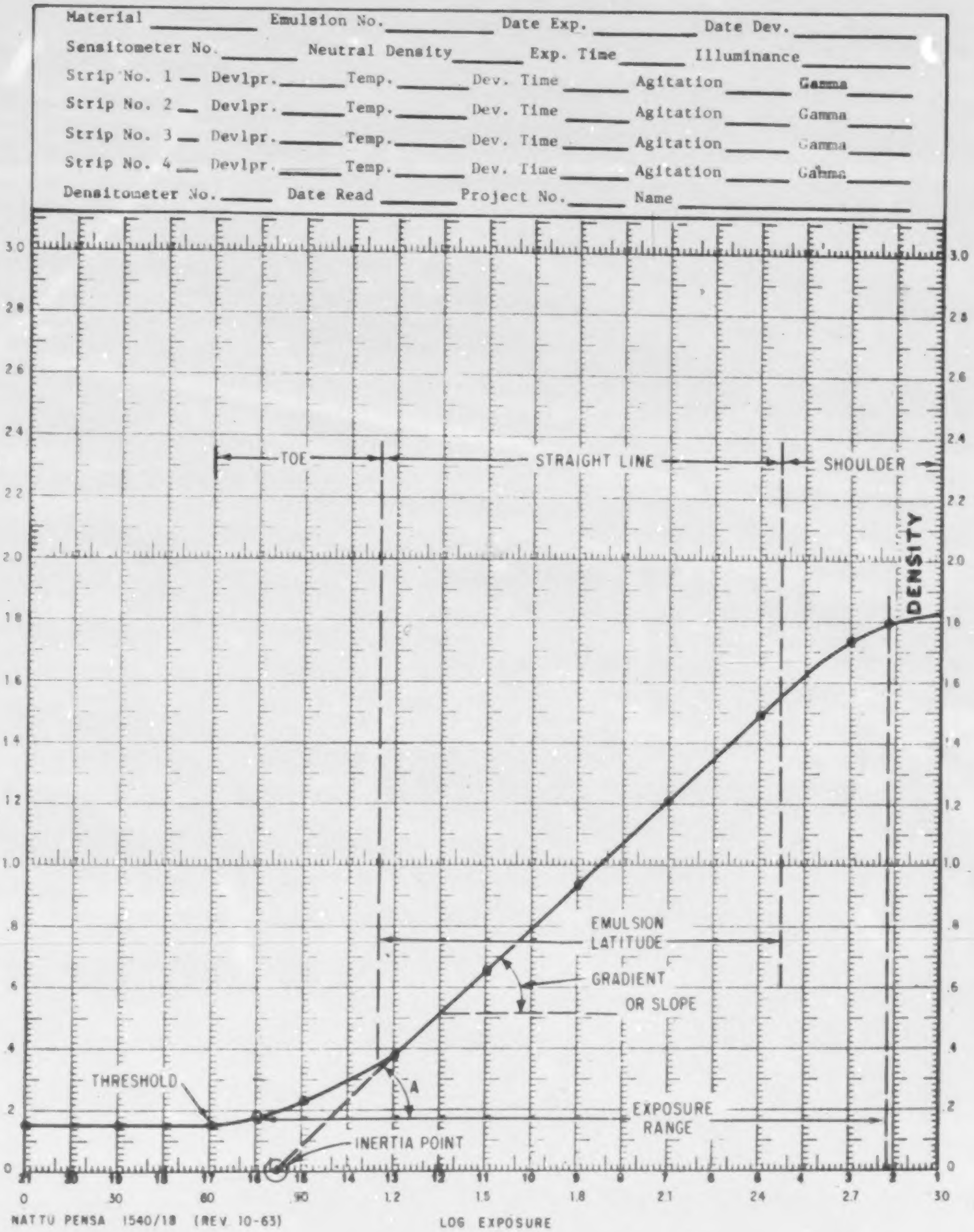


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Figure 6-8.—Typical characteristic curve.

the point of intersection is called the "inertia," or inertia point.

SHOULDER

The upper portion of the curve is a convex, curved line, gradually decreasing in slope, called the shoulder. This again is an area where equal changes in exposure do not produce equal differences in density. Tones of the subject falling very far up in this area will be blocked, that is, reproduced with densities too heavy for printing for maximum detail. For normal exposures, bright highlight tones of the subject tend to be reproduced in the shoulder portion of the curve.

EXPOSURE

If a uniformly lighted gray scale card is photographed, there is a single exposure corresponding to a single point somewhere on the log E axis. If the light on this surface is increased and another photograph made (maintaining the same camera settings), the exposure and the log E will also have been increased. This causes a shift to the right on the log E axis. The amount of shift depends upon the amount of increase in exposure.

If the subject consists of two areas, one reflecting more light than the other, there are two points determined on the log E axis. The separation between these two points depends upon the ratio of the light intensity being reflected by the two areas of the subject. An increase in the photographic exposure of this subject causes both points to shift to the right. The amount of shift depends upon the amount of increase. The two points move together, the distance between them being fixed by the reflectances of the subject and within limits unaltered by changes in exposure. Extending these differences to a scene having a large number of reflectances or tones, it can be seen that the tonal differences in the subject, the lighting, and the camera settings determine the exposure received by the film. Since the differences in the tones in the subject determine the spacing of corresponding points on the log E axis, the points may all be shifted to the right or to the left by altering the level of illumination or changing the camera settings.

DENSITY DIFFERENCES

The vertical axis represents the densities in the negative. It shows the way in which the tones of the subject are reproduced by the negative material. It is of minor importance whether the general density level is thin, moderate, or heavy. What does matter is the difference between tones. (Of course, it is important to consider the detail which can be seen in a negative, whether the shadows are flat or full of detail, and whether or not the high-lights are blocked up.) This is what is meant in sensitometry by the term, "density differences."

Density differences depend in part on the log E differences with which the process started. If the subject has many widely separated tones, large density differences are to be expected in the negative. Conversely, if the subject consists of tones all nearly alike, the negative can hardly be expected to contain much variation in tone.

It can be said that negative quality depends on DENSITY DIFFERENCES in the negative. These density differences must be related to the log E differences which produce them. That is, density differences in the negative must be considered in their relationship with the tones in the subject.

The density differences in a negative can be partially controlled by placing the exposures corresponding to the subject tones in the right portion of the characteristic curve. This is done by correct adjustment of the camera settings, provided that the range of tones in the subject is not too great.

EMULSION LATITUDE

The latitude of an emulsion is the exposure range over which a proportional relationship between density differences and log E differences is obtained. In other words, it is simply the range of exposures covered by the straight line portion of the characteristic curve. The latitude of an emulsion, therefore, determines the brightness range of the subject which may be proportionally reproduced. Latitude may be expressed either as the difference in log E values between the extremities of the straight line, or as the exposure ratio between these same two points.

The latitude of negative materials varies, according to the purpose for which they were designed–from 1 to 400 or more for a general purpose panchromatic film, to perhaps 1 to 20 or even less for process films. For any given emulsion, the latitude varies according to the gamma and becomes less as the gamma increases.

USEFUL EXPOSURE RANGE

The useful exposure range includes part of both extremities as well as the straight line portion of the curve. The useful exposure range of a sensitive material is generally greater than its latitude, since it is often possible to use portions of the toe and shoulder regions of the curve without sacrifice in the quality of the tone reproduction

The lower limit of the useful exposure range is the point on the characteristic curve at which the slope is 0.3 of the average slope for a log E range of 1.5. The upper limit of the range has not been fixed definitely but is generally taken to be at the point on the shoulder of the curve at which the fractional slope is also 0.3. In practice, many photographers use a much lower upper limit because of the high densities involved.

EXPOSURE LATITUDE

Exposure latitude is the allowable range of exposures for a given photographic emulsion, scene, and brightness range. A photographic emulsion will provide an acceptable negative at any exposure taken within the limits of its exposure latitude.

Exposure latitude is directly affected by the brightness range of the scene and the length of the straight line portion of the film's characteristic curve. If the useful exposure range of the film is used, the exposure latitude of the film will be greater, since portions of the toe or shoulder may be included along with the straight line portion of the characteristic curve.

Normally, the lower the contrast of the scene and the faster the film, the greater is the exposure latitude.

Modern high speed films have an overall exposure latitude of several stops for an average subject. However, color reversal film and very slow films have very little exposure latitude, regardless of the brightness range or scene contrast. Thus, the range of exposures lies within a very narrow limit (less than one to one-half stop).

GAMMA (γ)

In technical terms, gamma (signified by the Greek letter γ) is a sensitometric quantity which indicates the slope or gradient of the straight line portion of the characteristic curve of photographic emulsions. It is commonly interpreted as a measure of the contrast reproduced in a negative image, that is, the ratio of negative contrast to original subject contrast for a given range of tonal values. Therefore, one of the primary uses of gamma is its employment as a yardstick. It measures the degree of development of photographic materials, since changes in development vary contrast or the slope of the curve. (Exposure changes, as previously explained, shift the position of the points right or left on the log E axis without altering the slope of the curve. Thus, the tendency is for exposure to control the density and development to control the contrast of the image reproduced. Remember the expression, "Expose for density–develop for contrast.")

Gamma may be likened to the slope of a road. Mathematically, it is the ratio of the height gained to the distance traveled in a horizontal direction. In determining gamma, the height is density (D), and the horizontal base is the log of exposure (log E).

Materials capable of producing widely different gamma values are available. Normal photographic subjects call for films with a gamma value around 1.0, varying from 0.6 to 1.5. Such an emulsion will record the wide range of tones which are present in outdoor scenes. In practice, each of the main groups of negative materials have their own individual characteristics. Gamma is useful to the photographer because it tells him how his photographic material will respond to changes in exposure and processing.

From the foregoing discussion, it may be seen that gamma is definable in different terms. Some other useful definitions include the following:

1. Gamma is the numerical measure of the contrast reproduced in a negative image.

2. Gamma is a numerical measure of the degree of development (for a given material).

3. Technically, gamma is the slope of the straight line portion of the characteristic curve.

4. Mathematically gamma may be defined as follows:

   a. The ratio of the height gained (difference in any two densities on the straight line part of the curve) to the horizontal difference (difference between the log E's which produced the two densities).

   b. The tangent of the angle formed by the intersection of an extension of the straight line portion of the curve and the horizontal axis.

Gamma determination, once the curve has been plotted, can be accomplished by several methods. Four methods are presented here:

1. Basic Method. This method, shown in figure 6-9, involves the ratio between densities and the exposures which produced them. Any two points on the straight line are chosen. (More reliability tends to result if the points are widely separated.) Gamma is the result of dividing the change, or difference in density, by the difference in log E between the two points. The formula is

$$\text{Gamma} = \frac{\Delta D}{\Delta \log E} = \frac{D_1 - D_2}{\log E_1 - \log E_2}$$

where

Δ (Delta) = Greek symbol for change or difference.

2. Graphic Method. From the inertia point (the point of intersection of the straight line extended to the log E axis) move to the right a distance of 1.00 on the log E axis. Gamma is the density reading at this point.

3. Quick Method. This method uses a gamma meter (fig. 6-10). The arrow point of the meter is placed on the straight line portion of the curve, with the baseline of the meter parallel to the log E axis. Gamma is indicated where the straight line intersects the scale. Operational units can copy figure 6-10 to the scale indicated and thereby have at hand a rapid, accurate method of determining gamma.

4. Simplified Method. A point is selected on the straight line portion of the characteristic curve at one of the minimum densities. From this point, count over 50 spaces in a horizontal direction. Next, count the number of spaces in a vertical direction until the straight line portion of the characteristic curve is intersected. Multiply this figure by 2 and divide by 100. For example, if 40 spaces are counted, the calculation is as follows:

$$\frac{2 \times 40}{100} = 0.80 = 0.8 \text{ gamma,}$$

or

$$\frac{40}{50} = \frac{4}{5} = 0.8 \text{ gamma.}$$

Gamma and Contrast

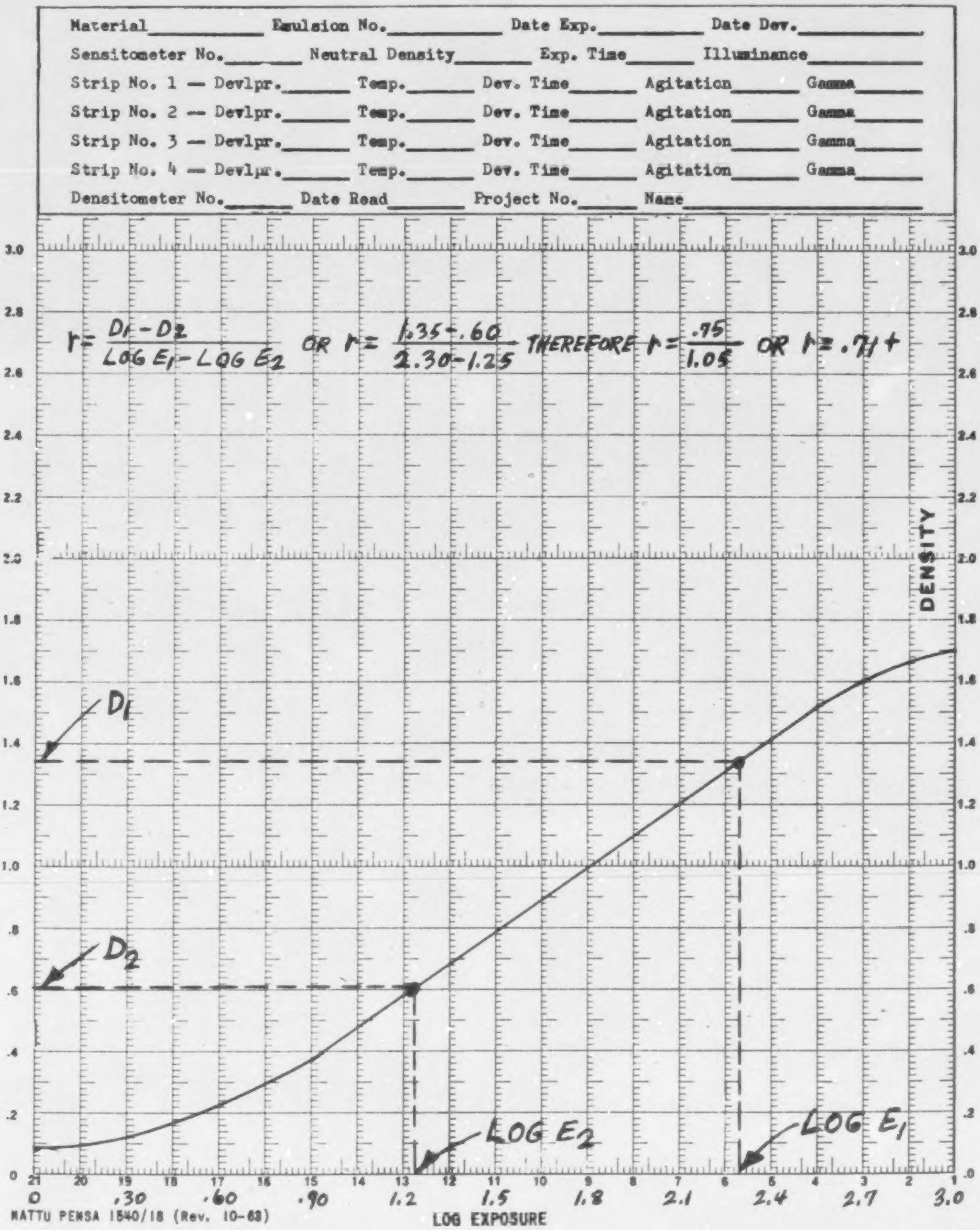
A negative contains many different contrasts. It has total contrast, defined as the difference in density between the extreme shadow and extreme highlight tones in the negative. Total negative contrast is a useful index to the paper grade on which the negative will probably print best. Total negative contrast is dependent upon many factors, including subject illumination ratio, camera exposure level, color of light, and gamma. Gamma is only one of the factors which control the total contrast of a negative. In addition, a negative has other forms of contrast as follows:

1. Shadow contrast associated with the characteristics of the toe portion of the characteristic curve and therefore unrelated to gamma.

2. Highlight contrast, associated with the shoulder of the characteristic curve and to which gamma does not apply.

3. Midtone contrast, associated with the straight line portion of the characteristic curve.

Gamma therefore is not a measure of negative contrast, nor will a control of gamma in different negatives insure that they will all print on the same paper grade. All of the frames in a roll of film may be uniformly developed to the same gamma; for example, 0.75. However, each negative will probably have a different total contrast because of variations in subject contrast, subject color, subject luminance, etc.



Material__________ Emulsion No.__________ Date Exp._________ Date Dev.__________

Sensitometer No._____ Neutral Density______ Exp. Time_____ Illuminance__________

Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

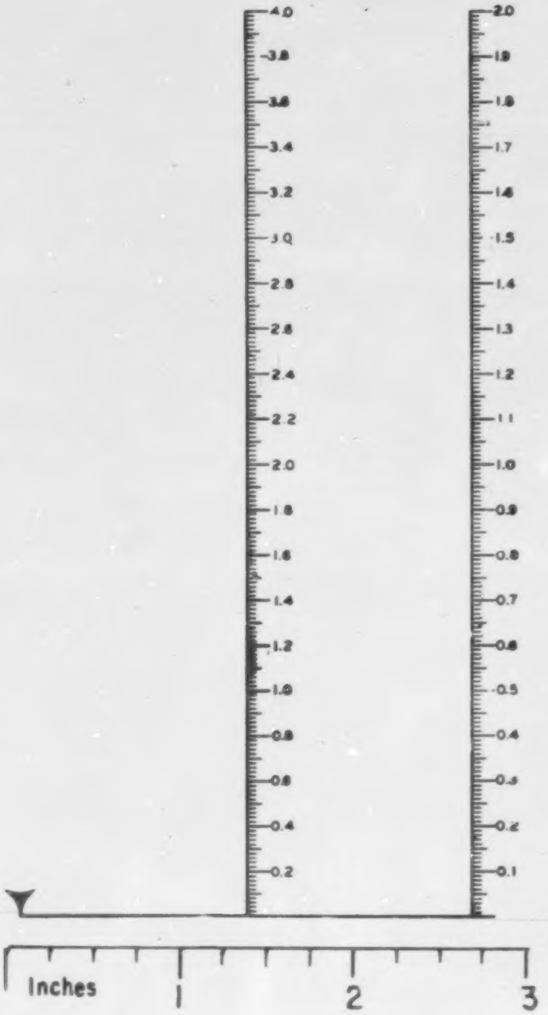
Densitometer No._____ Date Read______ Project No._____ Name____________________

$\gamma = \frac{D_1 - D_2}{LOG\ E_1 - LOG\ E_2}$ OR $\gamma = \frac{1.35 - .60}{2.30 - 1.25}$ THEREFORE $\gamma = \frac{.75}{1.05}$ OR $\gamma = .71+$

DENSITY
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
D_1
D_2
$LOG\ E_2$
$LOG\ E_1$
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
0 .30 .60 .90 1.2 1.5 1.8 2.1 2.4 2.7 3.0
LOG EXPOSURE
NATTU PENSA 1540/18 (Rev. 10-63)

PH.404

Figure 6-9.—Basic method of gamma calculation.



PH.405

Figure 6-10.–Gamma meter.

A photographic emulsion exposed on a dull cloudy day could be developed to a high gamma (for example, 1.6) and still produce a flat negative, because of the small luminance range of the subject being photographed. Another scene having a high luminance ratio could be photographed and developed to a low gamma of say 0.5, yet the contrast of the negative would be so high that it would have to be printed on a very soft paper.

It should be understood that even though a negative can have a high amount of total contrast, there may be little contrast in the shadows, if these shadows fall on the flat portion of the toe of the D log E curve. If two negatives having the same characteristics are exposed showing the same scene and at the same or nearly the same time, and each negative is developed to a different gamma, it is true that more contrast can be expected in the negative developed to the higher gamma. This is also true for those tones exposed on the straight line portion of the characteristic curve and to a lesser extent for tones exposed on the upper part of the toe.

If the basic formula for determining gamma is examined, ΔD may be considered the negative contrast (for the straight line) and $\Delta \log E$ the subject contrast. Gamma can then be considered as the ratio between negative and subject contrast. A negative that is developed to a gamma of 1.0 has for all straight line exposures the same contrast range as the original scene. If instead the negative is developed to a lower gamma (for example, 0.5), it will have only half as much contrast as the subject. Again, however, this applies only to the straight line portion of the curve. This restricts the application of gamma since many negatives are exposed on sections of the curve other than the straight line.

CONTRAST INDEX.–Gamma is useless for many modern photographic materials because of their irregularities in the straight line portion. Such irregularities can include complete lack of a straight line (in certain portrait films for example). In some photographic materials, two straight lines exist, each with different slope. Excellent negatives are being exposed on the upper part of the toe as well as the straight line. For these reasons gamma, for pictorial negative films, has largely lost the significance which it was once thought to have.

Recently the use of contrast index has replaced gamma for many purposes. Contrast index is the average of the slope, as distinct from the straight line slope of gamma. An average slope in this context is merely the slope of the straight line drawn between two definite points on the curve. The value of the slope will depend upon the points that are chosen.

Contrast index was developed as a result of extensive analysis of excellent negatives made on a great variety of negative films. The two defined points were arrived at by measurements made on these negatives.

Contrast index has the same uses as gamma: It is an index number that can be used for processing control purposes. When films or developers are compared, the test images should all be developed to the same contrast index. Obtaining a constant contrast index, like gamma, does not guarantee that all negatives will have the same total contrast, nor that they will all print similarly.

Determining Log E

The time of exposure is constant in an intensity-scale sensitometer such as the Eastman Kodak Model 60 and 101. The illumination affecting the material being tested is varied by exposing through a step wedge. The density of each step of the step wedge reduces the exposure proportionately. Therefore, in order to obtain the log E for each step, the density of that step is subtracted from the log of the exposure at the exposure plane.

Example:

Intensity of illumination in sensitometer	1,700 m-c
Time (one depression of shutter button)	0.10
Exposure	170.0 m-c-s
Log E (log of exposure)	2.23
Minus the neutral density filter installed in sensitometer	1.20
	1.03
Minus the minimum density of step wedge in sensitometer	-0.05
MAX LOG E (log of the maximum exposure the film received)	0.98

The MAX LOG E figure of 0.98 is, in this particular case, the log E that produced the maximum density on the processed film, and as such will fall on the shoulder of the characteristic curve under step line NO. 1. Since it is the log of the maximum exposure received by the film, and each of the remaining 20 steps is 0.15 greater, the remaining 20 log E figures can be readily determined by successively subtracting 0.15 as follows:

Step No.	Log E
1	0.98
2	0.83
3	0.68
4	0.53
5	0.38
6	0.23
7	0.08
8	$\bar{1}.93$
9	$\bar{1}.78$
10	$\bar{1}.63$
11	$\bar{1}.48$
12	$\bar{1}.33$
13	$\bar{1}.18$
14	$\bar{1}.03$
15	$\bar{2}.88$
16	$\bar{2}.73$
17	$\bar{2}.58$
18	$\bar{2}.43$
19	$\bar{2}.28$
20	$\bar{2}.13$
21	$\bar{3}.98$

These log E figures, although seemingly superfluous at this point, are invaluable in determining the various film speeds as well as being mandatory in application of the tone reproduction cycle.

CONTROL IN PROCESSING

The gamma value of a photographic material is not fixed. It can be varied within limits by the choice of developer and the method of development.

Gamma has been defined as the slope of the straight line portion of the characteristic curve. This is the only part of the curve in which significant changes in density are obtained by changes in development. For this reason gamma is useful as a measure of the degree of development. Gamma varies directly with development; the greater the development, the higher the gamma will be (up to gamma infinity).

The time of development is only one of the processing factors affecting gamma. Other factors are the type of developer used, dilution of developer, processing temperature, and the method of agitation. If the gamma is measured and found to be high, an appreciable amount of development was obtained, even though the developing time may have been short.

Gamma is one of the most important tools used in processing control. Negatives developed to the same gamma, for example, show comparable tone reproduction. If it is desired to determine that processing is consistent, sensitometric strips are run along with the material being processed and the gamma plotted. If the gamma remains constant, processing is consistent. Whenever practicable, the test strips should be printed on the material itself, such as on an edge of cut film or at the ends of rollfilm.

TIME-GAMMA CURVES

Time-gamma curves can be plotted to summarize the behavior of any film-developer combination. An ordinary time-gamma curve can be used to indicate the time of development required to reach the desired gamma, or the processing latitude for a specific gamma tolerance. Time-gamma charts can be made to show the maximum gamma (gamma infinity) obtainable with any film-developer combination.

Figure 6-11 illustrates a time-gamma curve and the family of curves which produce it. The time-gamma curve is constructed in this manner (assuming, as in the example, that the test strip which was developed for 3 minutes resulted in a gamma of 0.50, the 6-minute strip resulted in a gamma of 0.75, and the 9-minute strip resulted in a gamma of 0.90). A small graph is drawn in the upper left corner of the graph on which this family of curves is plotted. The horizontal axis should be marked off in time of development in minutes and the vertical axis in increments of gamma. The gamma obtained in each of the three strips is plotted against the time required to produce it by placing three dots in their proper position on the graph. A french curve is then used to connect the dots.

The time of development, for any required gamma within the range represented by the curve, may be obtained by constructing a horizontal line from the desired gamma on the scale to its intersection with the time-gamma curve. A perpendicular line from this point of intersection to the horizontal axis indicates the required time of development.

The gamma which is obtained by developing for any given length of time may be secured by reversing this procedure.

The processing latitude, that is, the range in times of development for any given tolerance in gamma, may be found by determining the time of development for the minimum and maximum gammas which are acceptable.

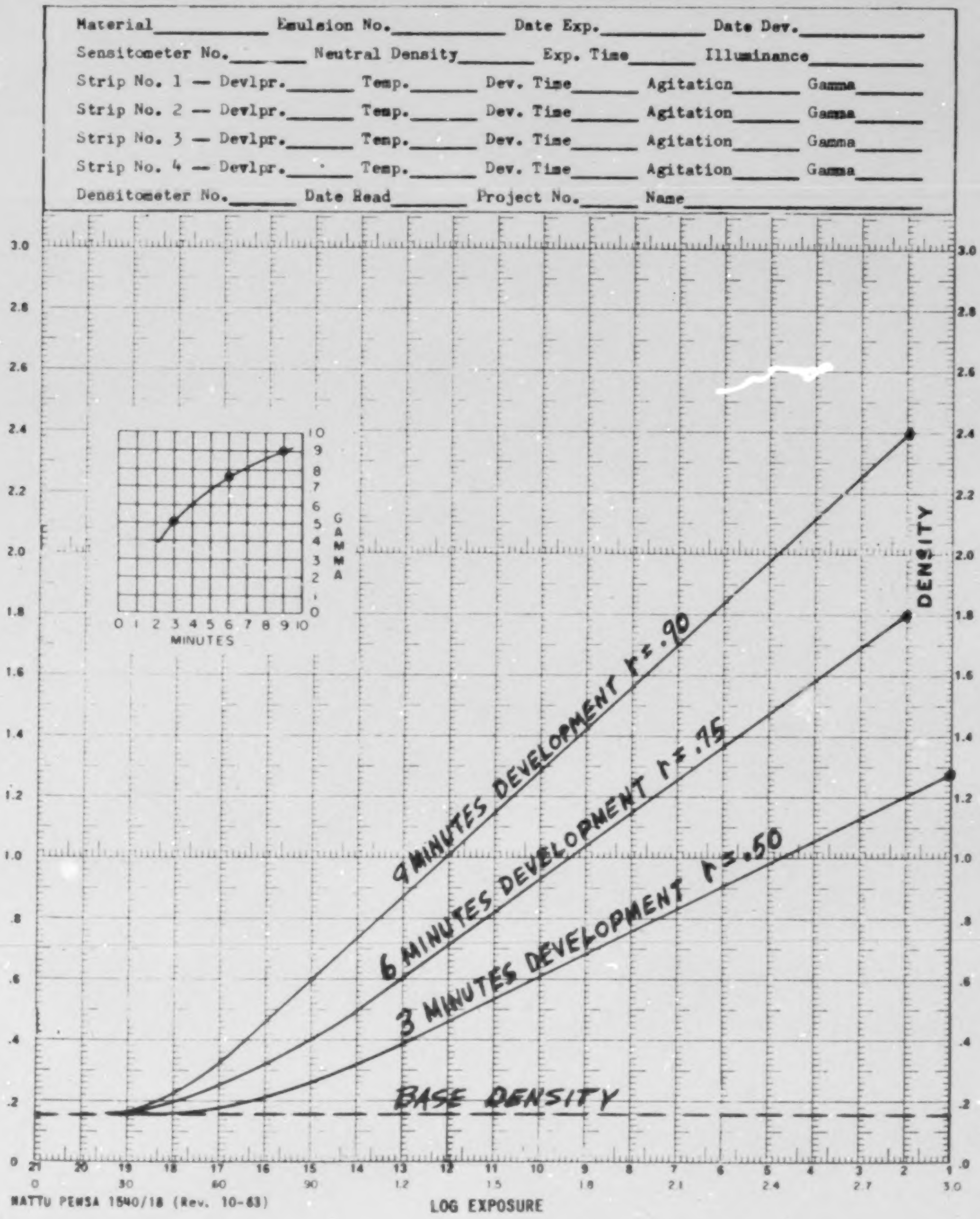
An examination of the time-gamma curve will show that as development increases, gamma also increases, rapidly at first and then more slowly; after a time there is very little increase in gamma even though development is prolonged. This indicates that for any particular emulsion and development condition, the higher the gamma, the greater the processing latitude. This also indicates that the lower the gamma, the more precisely the processing conditions must be controlled to obtain uniform development.

The highest gamma obtainable in any particular emulsion is called the "gamma infinity." It depends chiefly on the emulsion and to a lesser degree on the composition of the developer used. Typical gamma infinity values for some different types of emulsions (when processed in the developers normally used for them) are as follows:

1. High-speed portrait film	1.2
2. High-speed press film	1.7
3. Commercial film	2.0
4. Process film	3.0

TIME-TEMPERATURE CHARTS

One of the primary factors governing the density of an image is the temperature of the developer. The higher the temperature, the greater is the activity of the solution. As the temperature drops, the developing time must be increased. Since gamma must also be considered, typical time-temperature charts include a gamma value which varies according to development time and temperature. Designation of this value allows controlling of the development in order to produce a desired gamma. By consulting a



Material__________ Emulsion No.__________ Date Exp.__________ Date Dev.__________

Sensitometer No.______ Neutral Density_______ Exp. Time______ Illuminance__________

Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Densitometer No.______ Date Read_______ Project No.______ Name__________________

PH.406

Figure 6-11.—Time gamma curve.

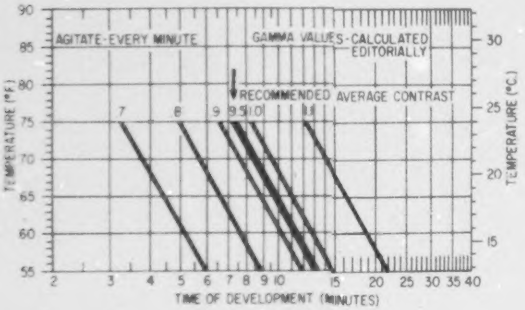
time-gamma-temperature chart, which is published by the manufacturer of the film, determination of the proper developing time under varying conditions may be made. A typical chart of this type is shown in figure 6-12.

As can be seen from figure 6-12, the time of development in minutes is shown at the bottom. Fahrenheit temperature is indicated on the left side and centigrade on the right. Follow the line indicating the temperature at which the emulsion is to be processed until it intersects the desired "gamma line." From this point, drop a perpendicular to the time base. The intersection of the perpendicular and the time-base line indicates the proper time at the recommended agitation. For constant agitation, the manufacturer will generally indicate a percentage figure showing the proper decrease in time.

CHEMICAL QUALITY ASSURANCE

The equipment and methods presently employed for compounding photographic solutions are the results of changes that have taken place over many years. These improvements have been made in order to keep pace with the general demand for better photographic quality now possible with advanced designs in optics, cameras, processing equipment, and the ever-increasing variety of sensitized materials.

The preparation of solutions, when taken as an operation, may be likened to the fulcrum of a balance. On one side are the optics and mechanics of exposure; on the other side are the chemical and mechanical conditions of processing. In other words, carefully controlled conditions of exposure demand equal care and control in processing. For optimum results, one must balance the other.



PH.407

Figure 6-12.—Time-gamma temperature chart.

THEORY

Substandard solutions make it virtually impossible to carry on a processing operation within controlled limits. Any degree of uniformity obtained from a controlled operation using substandard solutions is purely accidental and is not reliable.

The art of preparing and using solutions is no longer one performed by individuals (all of whom tend to introduce their own innovations dictated by personal experience), but it is a systematized procedure based on accurate measurement and standardized methods that must be controlled. The highest quality standards can be achieved only when the conditions of exposure, chemistry, and processing are all normal, or within operating tolerances. The net desired result, with its complete dependence on the above, is a predictable result.

In certain critical processing areas, chemical analysis is often used to check all solutions before they are used, to check them during use, to keep chemicals up to standard, and for locating troubles in faulty chemicals. Analysis of the components of processing solutions is often used as a basis for discarding solutions or adjusting their composition for future use. The use of such procedures permits the determination of proper replenishment formulas and replenishment rates and promotes economy in consumption of chemicals. The main asset of quality control procedures is that they act as a guarantee to insure that all solutions are properly mixed, properly used, and discarded at the proper time.

Important as chemical quality control procedures are, they must be supplemented with suitable sensitometric and/or picture tests. The chemical and photographic data can then be correlated to determine the control limits which are used by the laboratory. It is possible for sensitometric data to show a characteristic curve which is gradually bending out of shape, when the slope is changing, or when other variables seem to be entering the picture. The problem may be due to any number of causes; however, the chemistry of the photographic process should be examined for the possible cause. It may be found that the agitation method has been changed; then again, the cause might be due to improper compounding of the developing solution.

Chemistry of Development

Development is a process whereby the exposed silver halides are chemically reduced to metallic silver. The silver halides that are in the emulsion are usually one or more of the following: silver chloride, silver bromide, or silver iodide.

As development continues, the silver halides are reduced to metallic silver, and the chloride, bromide, or iodide is released into the developer. Since these halides are also restrainers, they act to decrease the action of the developing agent.

The developing agents are organic chemicals that, when mixed in a developer solution, reduce the exposed silver halides without affecting the unexposed halides. The agents commonly used are Metol and hydroquinone which are very complex in chemical structure. Generally, these agents will not satisfactorily develop the silver image by themselves and are used with an activator. Metol is a fast starting developing agent giving less density, while hydroquinone is slower in starting but gives higher density. The two are normally used together to obtain the speed and density desired in each developer formula.

An activator or accelerator has to be used with the developing agent to start and speed up the reduction action and to soften the emulsion to allow faster and better penetration by the other chemicals. The following alkalis are the most frequently used as activators. They are listed in order of activity—strongest to weakest:

1. Sodium hydroxide
2. Sodium carbonate
3. Sodium metaborate (Kodalk)
4. Sodium tetraborate (borax)

A given amount of silver is formed in much less time with high-activity developers than with low-activity developers. The activity of a developer is controlled to a large extent by the alkalinity of the solution. The alkalinity of a solution is generally indicated by pH values which will be discussed later. (The pH symbol signifies hydrogen ion concentration; a measure of the acidity or alkalinity of a solution.)

When the developing agents are mixed in water, a breakdown immediately starts, and the agents turn brown. If the alkali is added, this breakdown becomes much faster, so a chemical is needed to prevent this oxidation and keep the solution clear. This is the purpose of the preservative. Sulfite acts as a preservative by having a greater affinity for, or desire to combine with, oxygen than the developing agent. Therefore, it combines with available oxygen first, delaying the oxidation of the developing agent.

The restrainer (usually potassium bromide) when added to the formula does not have too much effect on the pH, but it has a very important effect on the density of the film being processed. Its purpose is to prevent the unexposed silver-halides and being developed. It does affect the rate of development to a certain extent and assists in producing a more even development. The amount of bromide for this action is small and is therefore very critical. Remember that film being processed gives off bromide which tends to increase the restraining action. Thus, the developing time must be increased if the developer is being reused.

Chemistry of Fixation

The purpose of the fixing bath is to remove the unexposed silver halides and make the image permanent. The chemicals used for this action are not very complex and have but one purpose—to clear the film. The control of fixing baths is largely based on the amount of sodium thiosulfate or ammonium thiosulfate in solution, which changes the insoluble silver halides to water-soluble salts. Either of these chemicals will work by itself, but several other chemicals are added to stop development, harden the emulsion, etc.

As other chemicals are added, there arises the need for still another chemical to keep the solution clear and preserve it. Sodium sulfite performs this function. Then, acetic acid is added to lower the pH and stop development of the film. Boric acid is added to buffer the solution so that it will stay at the same pH for a longer period of time. In some cases, a small amount of alkali is added instead of boric acid to act as a buffer.

The last chemical added is used to harden the emulsion. It is usually aluminum potassium sulfate, or, as it is commonly called, potassium alum.

Chemistry of Washing

The wash is important as it frees the film of all chemicals and byproducts of processing. If an efficient wash is available, there is no problem, but if large amounts of film or paper are processed in a short time, a periodic check should be run on the wash water to make sure that it is not contaminated.

ANALYSIS

Much of the chemical analysis which the photographer will be required to perform may be accomplished through the use of common sense. The same thing holds true here as it does in the visual quality assurance of negatives and prints. Such things as cleanliness, accuracy, and proper preparation of solutions should be practiced at all times. Contamination can ruin a developer in a short time; this, in turn, will ruin the film. Such things as dirt and dust in the solution can cause bad spots on the film. These are examples of the common-sense precautions mentioned above.

Care, Cleanliness, and Accuracy

Since considerable glassware is used when working with chemical solutions, it is wise to have at least a semipermanent area arranged to accommodate the materials of procedure. Shelves and racks should be made for convenience and safety. Work areas should be easily cleanable and well lighted. Proper ventilation is a must, and a constant temperature control is highly desirable since measurements are often affected by temperatures.

Glassware is obviously subject to breakage. Therefore, all shelves used should be covered with toweling to help protect the glass during storage.

Constant temperature water is required to maintain control during pH and specific gravity readings.

Before being used in mixing and measuring chemicals, all equipment should be cleaned with extreme care. Use a good quality detergent of medium strength to wash glassware and other vessels. Be sure the items that have been washed are well rinsed with clean tap water. Keep the entire wall area clean to prevent contamination and insure accuracy. The constant use of sponges and paper toweling will help to maintain the necessary state of cleanliness.

Determining pH

As defined earlier, pH is basically the measure of the degree of acidity or alkalinity of a processing solution, and as such, provides an invaluable aid in determining the degree of accuracy with which the processing solutions have been prepared. Photographic developers usually run from a pH of 8 to 12, while fixers range between pH 3.1 and 5.

The acid or alkali content of developers and fixers determines their activity and proper strength, which is measured in pH values. The following scale indicates the location of acids and alkalis by their pH value (strength).

	pH values	
acids	neutral	alkalis
1 2 3 4 5 6	7	8 9 10 11 12 13 14

With the proper equipment the pH can be determined and interpreted. A pH of 7 is neutral. Working down from this point, the figures indicate weak acids (6) on to strong acids at a pH of 1. Working up from a pH of 7, the figures indicate weak to strong alkalis.

The pH values are numbered on a logarithmic scale. From 0 through 6, each number indicates a degree of acidity 1/10 as strong as the preceding number, but 10 times as strong as the next succeeding or higher number. A solution with a pH value of four, for example, would have a degree of acidity 10 times stronger than a solution with a pH value of 5, but only 1/100 the strength of a solution having a pH value of 2. When determining the degree of alkalinity of a solution, figure in an opposite manner. From 8 through 14, each number represents a degree of alkalinity 10 times as strong as the last preceding number, but 1/10 the strength of the next higher number. For example, a solution having a pH value of 11 indicates that the solution has an alkalinity 1,000 times stronger than a solution having a pH value of 8, but it would be only 1/100 as alkaline as a solution having a pH value of 13.

Laboratory tolerances must be established for individual laboratories because of such things as differences in procedures, type of equipment, impurities in water, etc. To establish these standards, an average of at least 10 different batches of each solution should be taken and recorded. These batches should be mixed as they would be for regular use, but under very close control to insure that the solutions are mixed at the correct temperature, in the proper sequence, etc. This operation, carried out in conjunction with sensitometric strips, determines what the tolerance can be. This tolerance is the amount of variation which can be had in the pH while still producing results of good quality.

While control pH values will indicate the desired pH level of a particular processing solution, it must be understood that all subsequent mixings of a given solution will not yield the same, exact pH value. Thus, a tolerance limit must be established. A recommendation of the Society of Motion Picture Technicians and Engineers (SMPTE) shows that the mixing of a processing solution can be varied as much as plus or minus 10 percent without a significant effect on the processing level. This means, in effect, that a quick feasible establishment of the low tolerance limits for pH can be made by reducing by 10 percent the amount of each chemical used in mixing a processing solution. These -10 percent weights, when mixed in the normal volume of water, will show the effective result of a -10 percent error. Conversely, the same procedure with a 10 percent addition of each of the chemicals into a normal volume of water, will show the higher, or upper tolerance, limit. Thus, by establishing a control pH value and high and low tolerance limits, one will readily be able to determine whether or not a newly mixed processing solution is suitable for use.

pH METERS

Litmus paper can indicate whether a solution is acid, alkaline, or neutral, but it will not indicate the pH value. For this purpose a device known as a pH meter should be used. Two such instruments in current use in the Navy are the Beckman Zeromatic SS-3 and the Corning pH meter model 10. These meters are illustrated in figures 6-13 and 6-14.

The ability of a pH meter to accurately determine the pH value of a solution may be used for the following purposes:

1. To determine the exact replenishment rates for photographic chemical solutions.
2. To verify that chemicals have been properly mixed.
3. To assure standardization of the processing solutions.
4. To test prepared chemicals.

A pH meter consists of an amplifier meter having a scale that reads from 0 to 14 and electrode apparatus. The reference electrode and pH measuring electrode, or these two combined into one combination electrode, are the most common type in the Navy. The pH electrode actually measures the pH while the reference electrode, which contains the electrolyte solution, is used only to complete the circuit. Placing these two electrodes in a liquid completes the circuit. The first step in measuring pH is the establishment of a point of reference by a standardization procedure. To standardize the pH meter it is necessary to place the electrodes in a special solution.

Special solutions, known as buffer solutions, are available at exact pH values for precise standardization. Since they resist change in pH value at specific temperatures, their accuracy is dependable. Always select a buffer having a pH value as close as possible to the pH of the sample to be tested. For the most accurate measurements, insure that both the sample and the buffer solution are at the same temperature.

When measurements of a sample with a different pH range are to be made, it is necessary to standardize the instrument with another buffer having a pH value nearer the pH of the new sample.

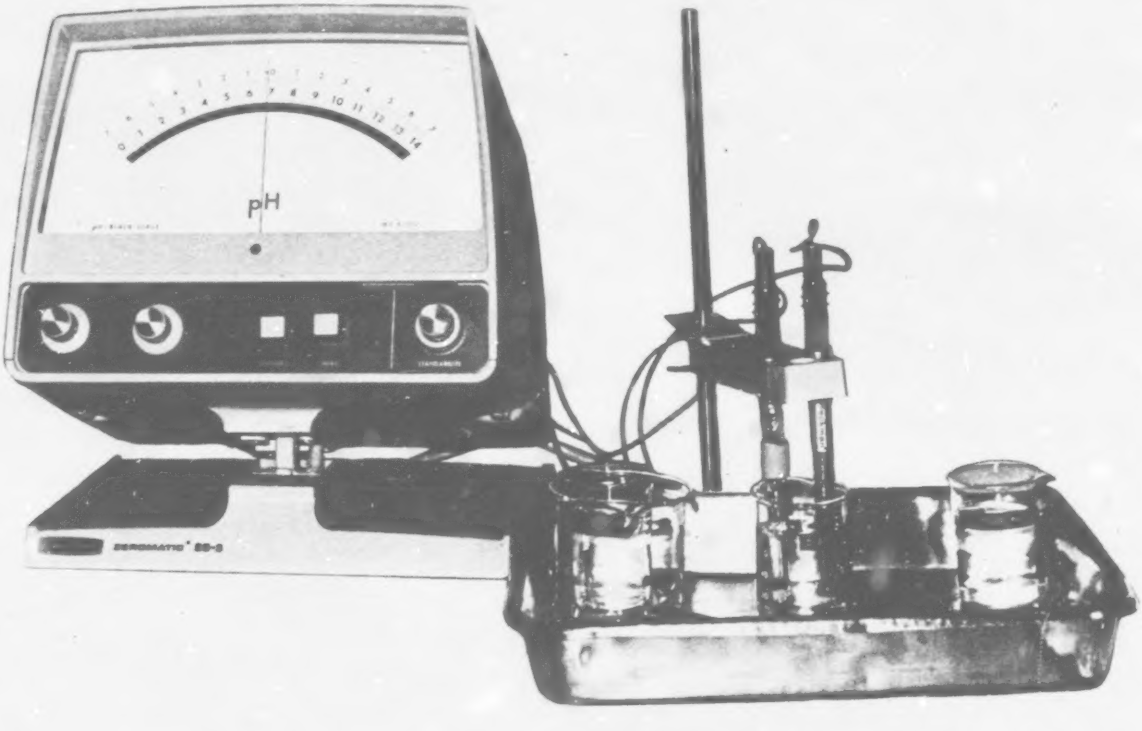
In addition, the instrument should be standardized at regular intervals during a long series of measurements, or every few days, to account for any changes in electrode asymmetry potential.

Measuring the pH value of a known buffer solution and adjusting the meter scale establish a reference point to use in the second measurement. The second measurement consists of reading the pH value of the sample. The pH value of the sample as read from the meter scale is relative to the pH of the buffer. Summarizing, the basic procedure for operating a pH meter is, first, to standardize the meter by measuring a buffer solution of a known pH value, then, second, to measure the pH value of the sample.

Buffers

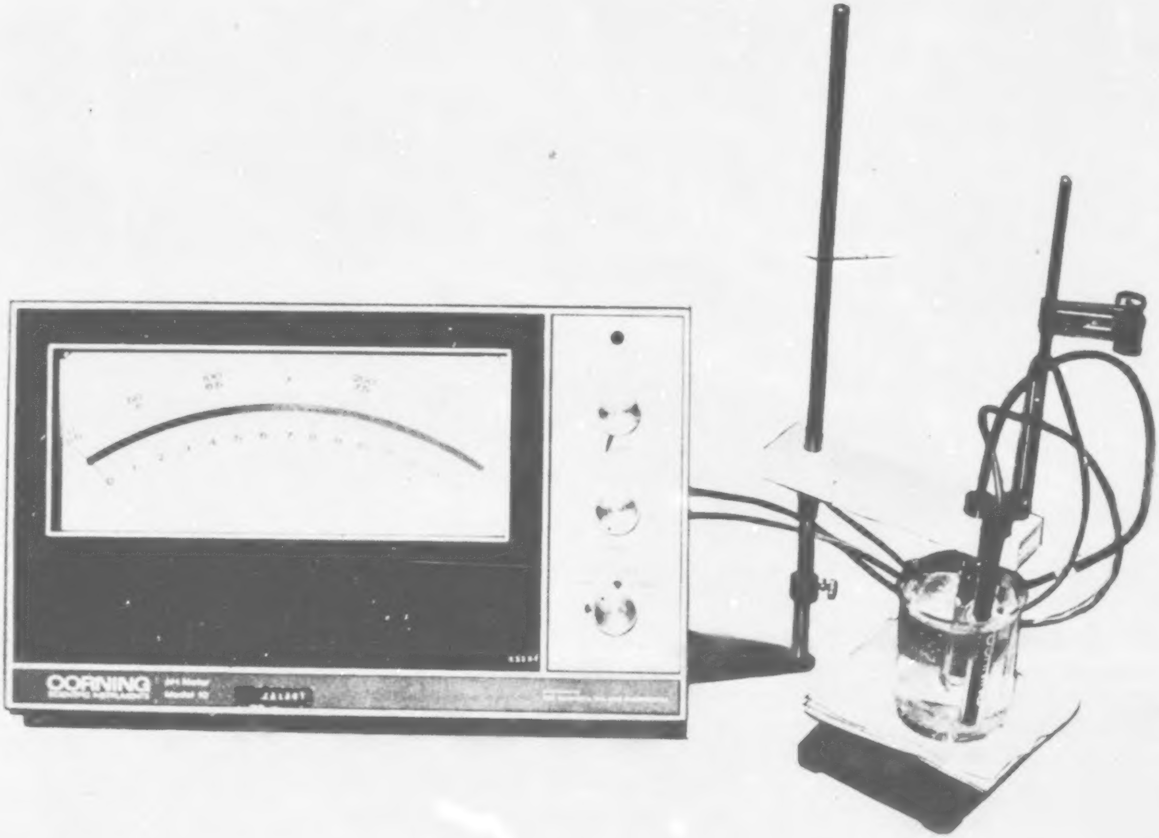
A buffer is a chemical solution which resists a change in pH. Adding a chemical that exerts a buffer action on a chemical solution tends to resist or retard any change in the pH of that solution. The closer a chemical is to a pH of 7, the better is its buffering action.

Acids are liberated into a developing solution by the action of the developer. To counteract this increase in acidity and maintain the necessary alkalinity of the developer, a buffer is added. Some examples of buffers used to maintain the alkalinity of a developer are sodium carbonate, sodium metaborate, and sodium phosphate, all of which are alkaline salts of weak



PH.408

Figure 6-13.–Beckman Zeromatic SS-3 pH Meter.



PH.409

Figure 6-14.—Corning pH Meter Model 10.

acids. The alkalis used in a developer are selected to provide buffering action at the desired pH level.

The buffer ordinarily used in fixing baths is boric acid. The addition of boric acid, which has a pH of 4.7 to 5.5, is necessary in maintaining the acidity of the acetic acid in the fixing bath. Any developer carried over into a fixing bath will drastically change its pH unless a buffer such as boric acid has been added to the fixer.

The pH of a fixing bath such as F-5A is approximately 4.9. If the pH of a fixing bath is too low, it will sulfurize. If the pH is too high (above 5.8), the sulfite and potassium alum in the fixer react with each other to form an aluminum sulfite sludge.

Potassium chrome alum is used as a hardener in tropical fixing baths. A hardener is used to retard excess swelling of the photographic emulsion at high temperatures. If the pH of a tropical fixing bath is above 3.9, the chrome alum forms into a chromium hydroxide sludge. This sludge is prevented by the addition of sulfuric acid as a buffer to maintain the pH value of the tropical fixing bath in a range of 3.1 to 3.8.

The gelatin of a photographic emulsion will swell the least when placed in a solution having a pH of 4.9. It swells at an increasing rate at pH values above or below 4.9 and also with increasing temperatures.

Most reducing agents in a developing solution require an alkaline solution before they will work. However, metol shows some activity in a mild acid solution. The action of the metol, and thereby the rate of increase in density, is gradually increased as the pH of the solution is increased. To show any results at all, a developing solution with a pH of at least 9.0 is required for hydroquinone.

The rate of activity of hydroquinone is much greater than that of metol. Therefore, hydroquinone is extremely sensitive to any change in the pH value of the developing solution. The contrast ability of any developer containing hydroquinone can be controlled by controlling the pH of the solution. Increasing the pH increases the contrast ability of the developer; conversely, decreasing the pH (a minimum pH of 9 is required) decreases the contrast ability of the developer.

A normal byproduct, hydrobromic acid, is liberated into the developer during processing. This decreases the pH of the developer which must be of an alkaline nature. This increase in acidity (decrease in pH) is counteracted by compounding the replenisher so that it will maintain the developer at the correct pH value.

The foregoing discussion of pH meters is intended as an introduction only. Detailed step-by-step operating instructions for pH meters are not included in this chapter. Operating instructions in the form of technical orders and applicable manufacturer's manuals for the pH meters the photographer will be using will be available to him in the photographic lab.

SPECIFIC GRAVITY

Another step in the certification of a solution prior to its use is the determination of its specific gravity. This check is one of the first tests made in verification of solutions. If the same chemicals are used in a formula, and if the same quantity of chemicals and an equal volume of water are used each time, the resulting liquid will have approximately the same specific gravity each time. This is a characteristic of that particular solution, provided that all measurements are made at a given temperature.

The specific gravity should stay within an upper and a lower limit determined for each solution. Variations beyond the upper limit—indicating a denser or heavier liquid—suggest that more than the forumla amount of one of the ingredients has been used, an ingredient foreign to the solution has been added, or the chemicals were not diluted properly. Differences in the opposite direction—measurements that fall below standard limits—might indicate that something has been left out, a foreign chemical has been substituted, or that more than the correct amount of water was added.

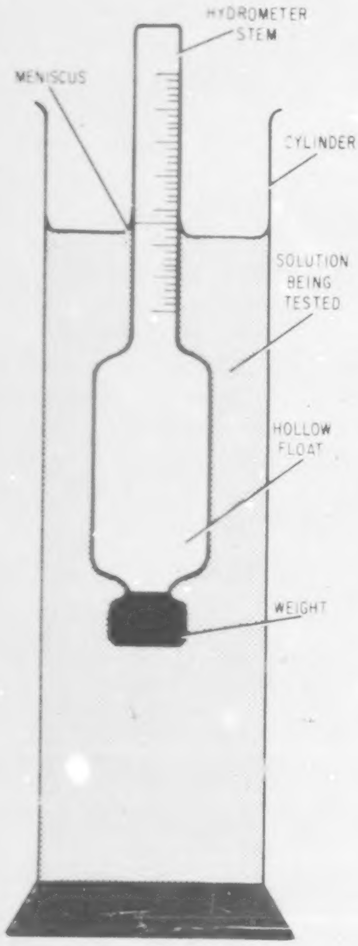
The silver content of a fixing bath increases as the bath becomes exhausted. This causes the specific gravity of the solution to rise. Hence, in addition to testing the consistency of chemical solutions, specific gravity tests may be used to check the amount of silver in the fixing bath. A hydrometer used for this purpose must be calibrated in grams of silver per liter of solution.

A hydrometer consists of a hollow tube with an enlarged lower section, or float, topped by a stem of narrow diameter. (See fig. 6-15.) The lower section is weighted, so that the hydrometer will float in liquids with its stem protruding from the surface. The stem is graduated with marks which are used to indicate the density of the liquid in which the hydrometer floats. When the density of the liquid is high, it supports the hydrometer more easily, so that less of the stem is submerged. Less dense liquids allow the hydrometer to sink deeper.

Hydrometers are commonly graduated in terms of specific gravity, which is the ratio of the density of a substance to the density of water. However, they may be designed for special purposes, with resulting differences in the graduated scale. An example is the hydrometer mentioned previously, which is used to check the silver content of a fixing bath.

Hydrometers used in chemical and photographic laboratories are normally supplied with a glass cylinder which serves as a container for the solution being tested. (See fig. 6-15.)

Due to the effects of surface tension and capillary action, a meniscus is formed at the interface between the solution and the hydrometer stem. (See fig. 6-15.) The reading is taken at



PH.410
Figure 6-15.—Hydrometer.

the point where the top of the meniscus intersects the stem of the hydrometer.

Specific Gravity Testing

To test the specific gravity of a solution, proceed as follows:

1. Fill the hydrometer cylinder with the sample to be measured.
2. Adjust the temperature of the sample to the temperature specified for the hydrometer. NOTE: This is important only for exact readings of the sample. For most practical purposes the ambient temperature of the solution can be used. However, all future readings must be taken at that particular temperature.
3. Insure that the tube is thoroughly dry. Then carefully lower it into the sample.
4. Read the hydrometer at the top of the meniscus as seen along the side of the hydrometer stem. (See fig. 6-15.)
5. Compare the readings with the prescribed standard. Deviations beyond limits call for a new sample and another reading. If the second reading is also outside the limits, the validity of the solution is questionable, and should be carefully correlated with the results of other tests. Personnel concerned with the mixing of developers and fixers must be on the lookout for any specific gravity reading that varies from the normal.

As mentioned earlier, a check on specific gravity is usually the first test to be made. Oftentimes, when a specific gravity reading is off, a check can be made and the cause found (e.g., if a certain chemical were omitted). Sometimes this chemical can be added to the solution, saving the expense and time of remixing.

As a matter of reference, the following are the control specific gravity factors determined at NATTU, Pensacola:

Specific Gravity of Developers

Type	Specific Gravity (68° F)
D-19	1.136
D-72	1.111
NRD-25	1.071
NRD-37	1.065

Specific Gravity of Fixers

Type	Specific Gravity (68° F)
F-6	1.142
NRF-5	1.109

Again, it is emphasized that while the above figures are valuable as a reference, they are accurate only at NATTU, Pensacola. Each unit must determine specific gravity factors based on local water supplies and conditions. The establishment of specific gravity tolerance limits can be made by means of the plus or minus weight method discussed earlier under pH.

SENSITOMETRIC CONTROL OF DEVELOPMENT

Once the developer has been mixed, a sensitometric strip should be processed to determine the results of the developer solution. Assuming the pH and specific gravity measurements of the developer are within tolerances, this solution test is certain to prove out the developer.

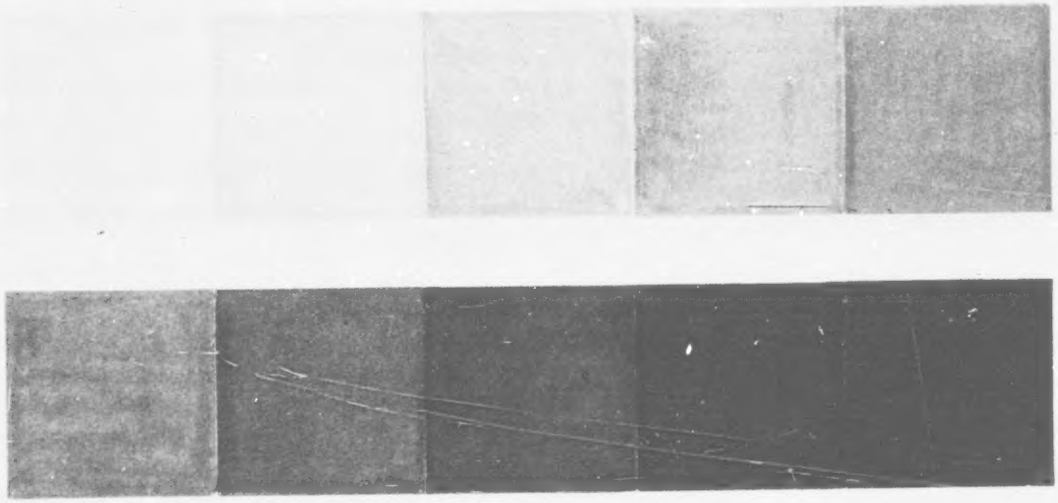
If this is a new formula for a developer that is being used, then time-gamma charts should be made up for the variety of films that are to be processed in the solution. Once these time-gamma charts have been made, the person processing is sure that he will get a known result with a given time, temperature, and agitation of the film in the developer.

After the developer solution has been proven, it is recommended that a sensitometric strip be processed with each batch of film processed. Then each sensitometric strip should be read with a densitometer. (Refer to fig. 6-16.)

Once densities are recorded and plotted, the gamma and average density ($\overline{D}$) can be determined and plotted on the applicable control chart. (The density of step No. 11 is normally used as $\overline{D}$, and in order to facilitate ease in locating, is usually circled when plotted.) If this procedure is followed continuously with each batch of film processed, one will have an accurate pictorial indication of the processing level.

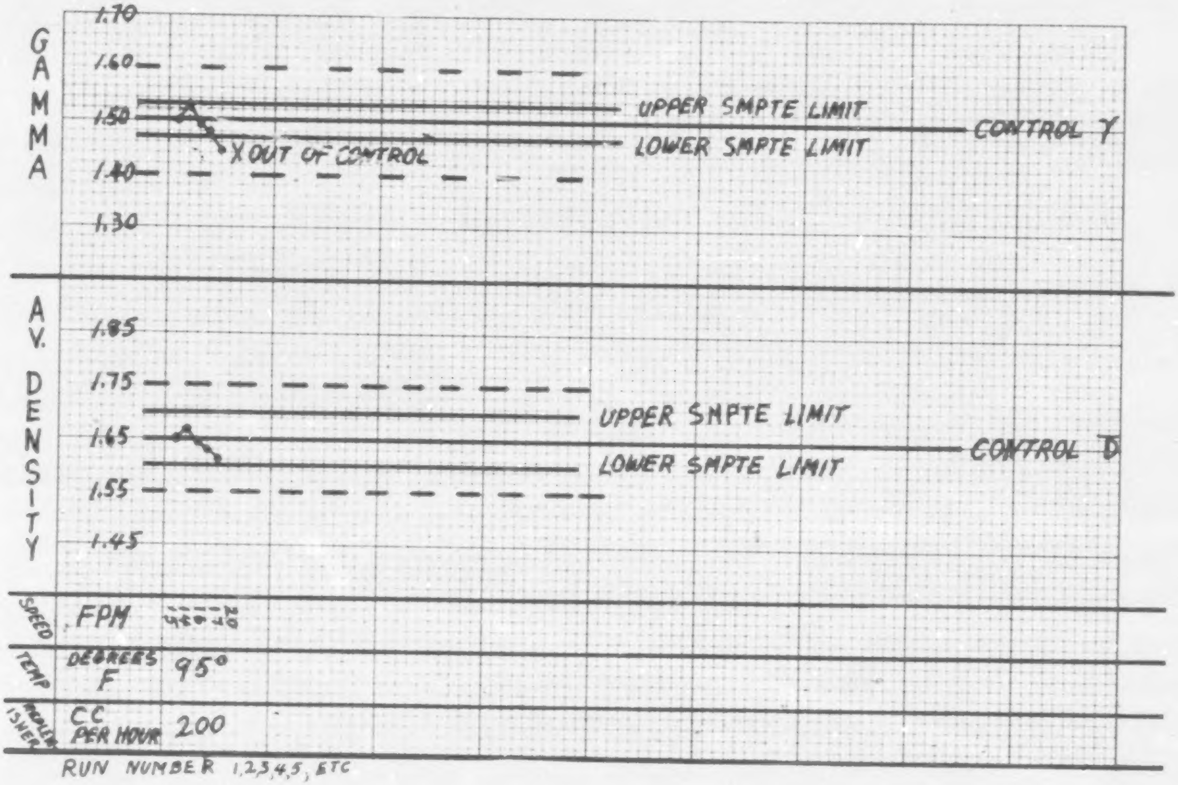
At this point it becomes necessary to once again mention tolerance limits. As valuable as a control chart might be, it is useless unless some indication is made as to when the process is out of control; i.e., the establishment of tolerance limits. If, for example, the control gamma in an aerial film processor such as the EH-38A is 1.50 and the desired average density is 1.65, one must have a method for indicating when the gamma and/or $\overline{D}$ have varied to the point to which the end result is no longer desirable. The gamma tolerance limit is ±0.05 and the $\overline{D}$ tolerance limit is ±0.07. If these tolerance limits are used with the control gamma and $\overline{D}$ previously mentioned, the control chart will appear as illustrated in figure 6-17.

As is indicated on the control chart, the gamma and D obtained on each run is appropriately plotted along with other pertinent data such as time or machine speed, temperature, rate of replenishment, footage processed, etc. The dots are then connected and thus show pictorially



PH.411

Figure 6-16.—Exposed and processed sensitometric (control) strip.



PH.412

Figure 6-17.—EH-38A control chart.

what the processor is doing at any given point. It is understood that fleet units, when initially setting up a process under controlled conditions will find it almost impossible to operate within SMPTE limits; therefore, it would perhaps be advisable to extend the tolerance limits (as indicated by the broken lines) for a short period of time until the machine operators have gained a degree of proficiency in machine adjustments and operations. The important fact to remember is that tolerance limits, once set, need not be left there forever. Each unit should continuously strive to improve the degree of control and, as such, should periodically reestablish closer tolerance limits.

The main concern of controlling the photographic development process is to attempt to keep all factors equal from one batch of film to the next. The time, temperature, agitation, and the developer solution itself all must be controlled to insure like results time after time. This fact cannot be stressed too heavily. Through the use of the pH, specific gravity, and sensitometric strips, the process may be controlled to get repeatable, reproducible results.

Replenishment is employed in an attempt to control the developing process. In conjunction with this replenishment, quality control charts are usually maintained. The individual requirements of each laboratory will determine the exact standards to be used. Once these standards have been determined, the next step is to establish a replenishment program, using a formula designed to fit the situation.

Manufacturers of photographic materials and chemicals have made available replenishers for most of their formulas. These perform satisfactorily for all except possibly the most critical situations. Replenishment formulas can be found in the Photo-Lab-Index. When using replenishers, be certain to follow the manufacturer's instructions to the letter. Some developers require addition of replenisher in accordance with the amount of film that has been processed. This system forces one to keep accurate records of the amount of film that has gone through the processing system.

While replenishment is an approved system, it can efficiently function for only so long a time. It is impossible to provide for an exact replacement of all chemicals as they are used. Eventually, the developer no longer functions properly, even with replenishment, and it is necessary to start with a completely new solution. Be sure not to try to push replenishment beyond its maximum capability. If this is done, uniform quality is impossible to attain.

Finally, remember that the $\overline{D}$ figures which can be determined from sensitometric strips will aid in indicating the proper rate of replenishment. A steadily increasing $\overline{D}$ indicates too rapid a rate of replenishment, while a drop in $\overline{D}$ indicates an insufficient replenishment rate. $\overline{D}$, then, combined with gamma, pH, and specific gravity, provides a system by which one finds it possible to maintain a completely controlled, replenished system.

MECHANICAL CONTROLS

Controls of the chemical process used in photography has been discussed; however, the mechanical factors involved in the photographic procedure should not be overlooked.

There are too many photographers who feel that when they expose a sheet of film for 1/50 second at f/8, the camera shutter opens and closes in 1/50 second and the lens transmits the light intensity that the f/8 stop mathematically transmits. The shutters of very few cameras expose precisely for the length of time indicated on their shutter speed rings. Also, no lens transmits the exact amount of light the f/stop setting indicates it should.

When using an exposure meter for determining exposure, does the reading obtained truly indicate the accuracy of the exposure meter? Make a test of this with any two meters in the laboratory. There will possibly be a variance of as much as a full f/stop's difference between these two meters, even though they are the same type.

Before a photographer starts to use a camera system for shooting jobs, he should completely check out the camera system under all of the conditions of available light, daylight, flash (electronic flash or flashbulbs), and artificial lighting. As a result of these tests, he insures proper exposure under varying conditions and better understands the characteristics of both camera and meter.

Suppose a Photographer's Mate is assigned to a shooting crew of the photo lab. Under lab policy he is issued a camera, light meter, and flash unit for his use while attached to the crew. The photographer wants to determine the characteristics of the equipment, so he loads the camera with the type of film used for the majority of photographic assignments. He sets the guide number of this film into the meter.

Next, a series of test exposures is made under the various conditions that may be expected. For daylight exposures, shoot an exposure at the setting the exposure meter indicates. Shoot another exposure at one f/stop greater than indicated by the meter, and still another at two f/stops greater than indicated. Then shoot one exposure at one f/stop decrease from that indicated by the meter, another at two f/stops decrease. Finally, process these films to the gamma the lab has set as standard (usually 0.8 gamma).

After processing, make a print of each on number 2 grade paper. The negative that renders the best print is selected as the one given the proper exposure. Assuming that the best print was made from the negative that was given a one f/stop increase, the photographer can say with reasonable certainty that his meter will render a one f/stop underexposure consistently, under daylight conditions. To correct for this variation, the film speed rating should be decreased one-half on the meter setting. Automatic compensation for the underexposure conditions will then be effected.

The same procedure should be carried out for photography using the flash unit. The procedure is the same except that any variation in exposure may be automatically effected by altering the guide number the correct amount instead of the film speed rating as above.

With the exposure system checked and corrected as outlined, the photographer gains a definite advantage in knowing the results his camera system gives under all conditions. He is free to concentrate on lighting, posing, and other aspects, rather than being faced with the constant worry of correcting exposure.

TONE REPRODUCTION

Some type of tone reproduction control is exercised in any photographic laboratory. This control may involve only a visual inspection of photographic quality, and a personal evaluation of the results based on past training, experiences (trial and error), and intuitive judgment. This is a valid and useful procedure in many situations. However, optimum photographic quality depends upon more objective and repeatable procedures, based upon measurable sensitometric parameters.

In tonal reproduction methods, photographers are concerned with the tonal relationship between the photographic image and the scene it represents. The relationship between the luminance and luminance differences in the original scene and the density and density differences in the photographic reproduction are determined by using sensitometric methods to provide quantitative measurements. A comparison of the relationship between luminance and luminance differences and between density and density differences determines whether or not a process has met (or can meet) either the requirements for exact objective tonal reproduction or a modification in a known manner of the objective's tonal range. The density range of the original negative and any following generation duplicate will have to be either sustained, compressed, or expanded, in order to retain the desired tonal relationship between the original scene and subsequent photographic reproductions. Selectively sustaining, compressing, or expanding the density range requires placing the imagery on a specific region of the characteristic (D log E) curve. This is predominantly the straight line upper portion of the toe. (Refer to fig. 6-8.)

Haphazard placement of the image on the characteristic curve may produce the desired density. However, this practice will likely be at the expense of excessively compressing one section of tones while expanding another. One satisfactory method of obtaining the desired tonal relationship between the original scene and subsequent photographic reproductions, such as duplicate negatives, positive transparencies, and/or prints, is the trigradient tone reproduction method.

TRIGRADIENT TONE REPRODUCTION METHOD

The trigradient tone reproduction method is an objective method for determining printing and processing requirements. This method enables the operator to select one of three standardized processes. Each process produces a different contrast or gradient. The processing requirement is determined by selecting one of the three processes relative to whether the density range of the duplicate should be decreased, increased, or maintained with respect to that of the imagery being duplicated. This enables the density range of the imagery to be altered, if necessary, in each generation so that the density range of the final product more nearly conforms to the desired density difference (usually 1.0). The printing requirement is then selected, relative to the process, to provide the desired tonal values (usually based upon a $\overline{D}$ minimum of 0.40).

Tone Control Curves

The tone reproduction method is based on the following sets of tone control curves:

1. High contrast;
2. Medium contrast;
3. Low contrast.

Each set consists of a series of response curves that graphically display the tones that are produced in the duplicate, when a step table used to simulate the densities of the image to be duplicated is printed under various conditions. Each curve is labeled with the amount of neutral density used in printing.

These response curves enable the density range of the imagery to be altered so that the density range of the final product more nearly conforms to the desired difference (1.0). The exposure on the printer is of utmost importance since it determines the placement of the tonal values of the imagery being reproduced on the sensitometric response curve of the duplicating material.

Ideally all tones should fall on the straight line portion of the response curve to insure reproduction in a uniform, linear manner. Most duplicating films, however, do not have a linear response so the straight line and upper toe portions of the characteristic (response) curve are used. The maximum useful density of imagery to be duplicated is used as the basis for computing the required exposure since it will be reproduced as the minimum useful density in the reproduction.

Procedure

To utilize the trigradient method for tone reproduction, proceed as follows:

1. Obtain the three sets of tone control curves (high, low, and medium contrasts) for the particular duplicating materials to be used.
2. Determine the minimum and maximum useful densities from the roll of imagery to be duplicated.
3. Compare the density difference and determine if the tonal range should be increased, decreased, or retained in order to obtain the desired density range (usually 1.0).
4. Based upon the results of step 3, select the appropriate set of response curves to be used (high, low, or medium).
5. Determine the $\overline{D}$ minimum aim point for the duplicate, usually 0.40.
6. Locate, on the tone control graph, the intersection of the projections of the $\overline{D}$ minimum aim point and the useful $\overline{D}$ maximum of the imagery that is to be duplicated.
7. The printing instructions to be used are those that were used to expose the characteristic (response) curve which passes through the intersection. If necessary, interpolate to compute the precise value.
8. Process the imagery in the same manner as that received by the samples from which the tone control curves were obtained.
9. Densitometrically evaluate the processed material to determine if the desired tonal relationships were obtained; i.e., the desired $\overline{D}$ minimum and $\overline{D}$ maximum values.

In order for this system to be accurate and reliable, all of the major variables must be controlled so that they can be carried out on a repeatable basis for many months.

Additional information on quality assurance procedures and techniques may be found in section IV and V of the Photographic Processing Standards Manual, NavAir 10-1-792.

CHAPTER 7

MACHINE PROCESSING

Semiautomatic continuous processing machines for photographic film and/or paper are utilized in Navy laboratories, ashore and float, where large amounts of aerial or motion picture work are performed. Some of the processors most likely to be encountered are covered in this chapter.

PROCESSING MACHINE EH-38

The most common automatic film processors in use, throughout naval photography, are the Versamat processors manufactured by the Eastman Kodak Company. They are referred to in the Navy as the EH-38 series. Since the introduction of the Versamat model A processor (Navy model EH-38A), there have been two later models put into use, the B and C models. For purposes of discussion in this text, only the EH-38C will be covered. Credit is given to Eastman Kodak Co. for permission to use material from their Service Manual and Installation and Operation Manual on the Kodak Versamat processors.

There are two different processors in addition to the EH-38 series that have many of the same features of the EH-38. These are the EH-66 and the EH-73 processors.

DESCRIPTION

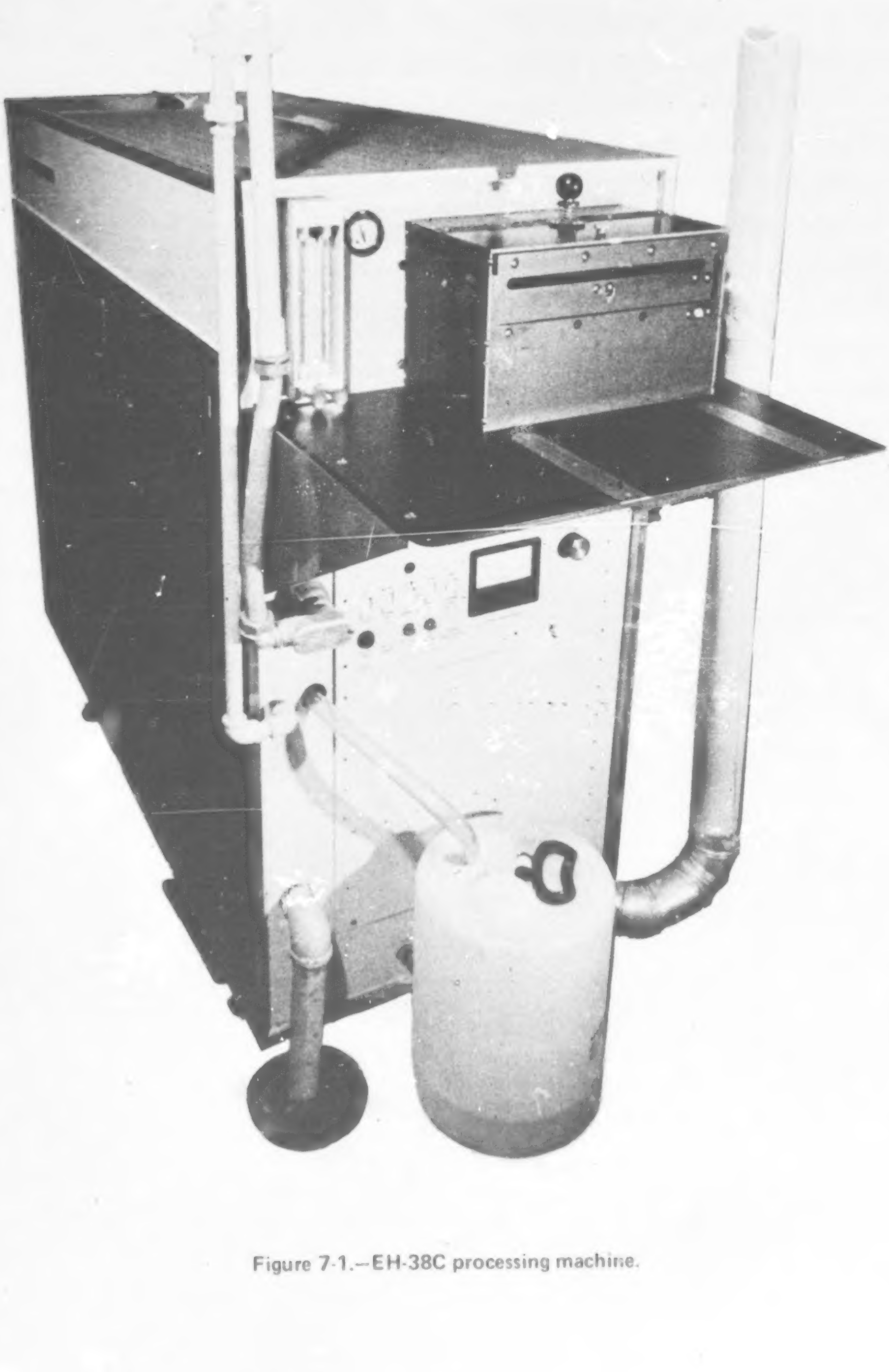
The EH-38C processor (fig. 7-1) is an automatic, self-threading, leaderless roller-transport processor designed for rapid processing and drying of continuous lengths of black-and-white rollfilms from 16mm to 9 1/2 inches wide. It will also process sheet film ranging in size from 4 x 5 inches to 11 x 14 inches and roll type, water resistant paper up to 9 3/8 inches wide.

The EH-38 processing machine is the mechanical portion of an automatic, rapid processing system. The other portion of the system is the chemistry (chemical processing solutions). The processing solutions used in these machines are especially made to condition the film so it can be transported through the processor without damage. If chemical processing solutions not designed for use in these machines are substituted, film and mechanical damage could result.

NOTE: It must be strongly emphasized that the chemical and mechanical functions in the automatic film processing system are, of necessity, closely related to each other. Some difficulties which might occur would normally appear to be mechanical, but in reality, could be traced to exhausted or improperly mixed chemical solutions. Thus it is important to determine first whether a malfunction is mechanical or chemical. After this is determined, it is strictly a matter of changing to fresh solutions—properly mixed and replenished, or repair or replacement of parts, to restore the processor to good working order. Just remember, it is important that this mechanical-chemical relationship be recognized and understood. There will be little difficulty in keeping the processor in good operating condition if this is done.

SYSTEMS

The EH-38 processor, as well as the EH-66 and EH-73 processors, is divided into eight systems—the roller-transport, main drive, developer recirculation, replenishment, water circulation, air circulation, electrical, and supply/takeup assemblies.



PH.413

Figure 7-1.–EH-38C processing machine.

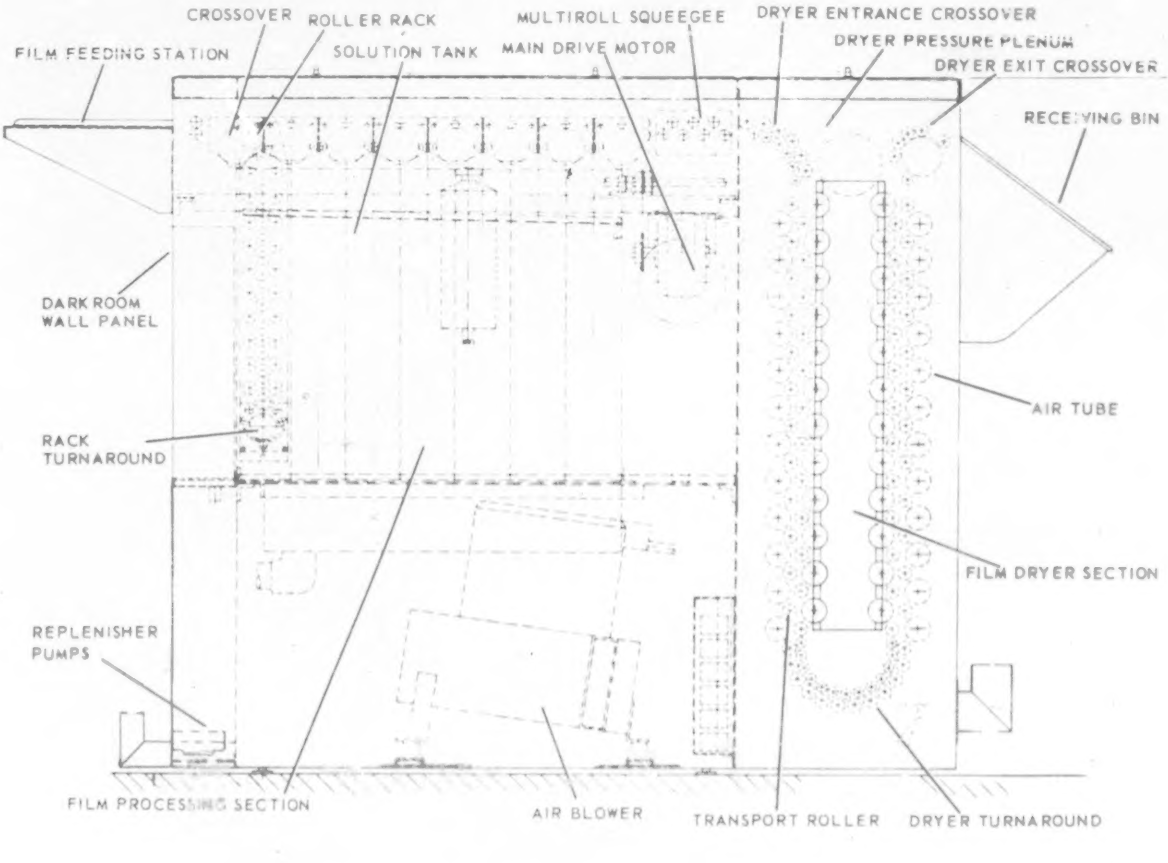
Roller-Transport

The complete roller-transport system, employing modular construction, consists of seven racks, eight crossovers, and the multi-roll squeegee in the processing section. Two racks are for developer tanks, three for fixer tanks, and two for the spray-wash tanks. The dryer section has two crossovers, transport rollers, a turnaround, and air tubes. The film path in each roller rack is between chain-driven rollers that are mounted in a slightly staggered path. As the rollers rotate, the film is conveyed from roller to roller throughout the system. (See fig. 7-2.)

The modular construction technique used in the manufacture of these processing machines can be seen in figure 7-3. These parts of the roller-transport system are only samples and are not all the modular components that make up the system.

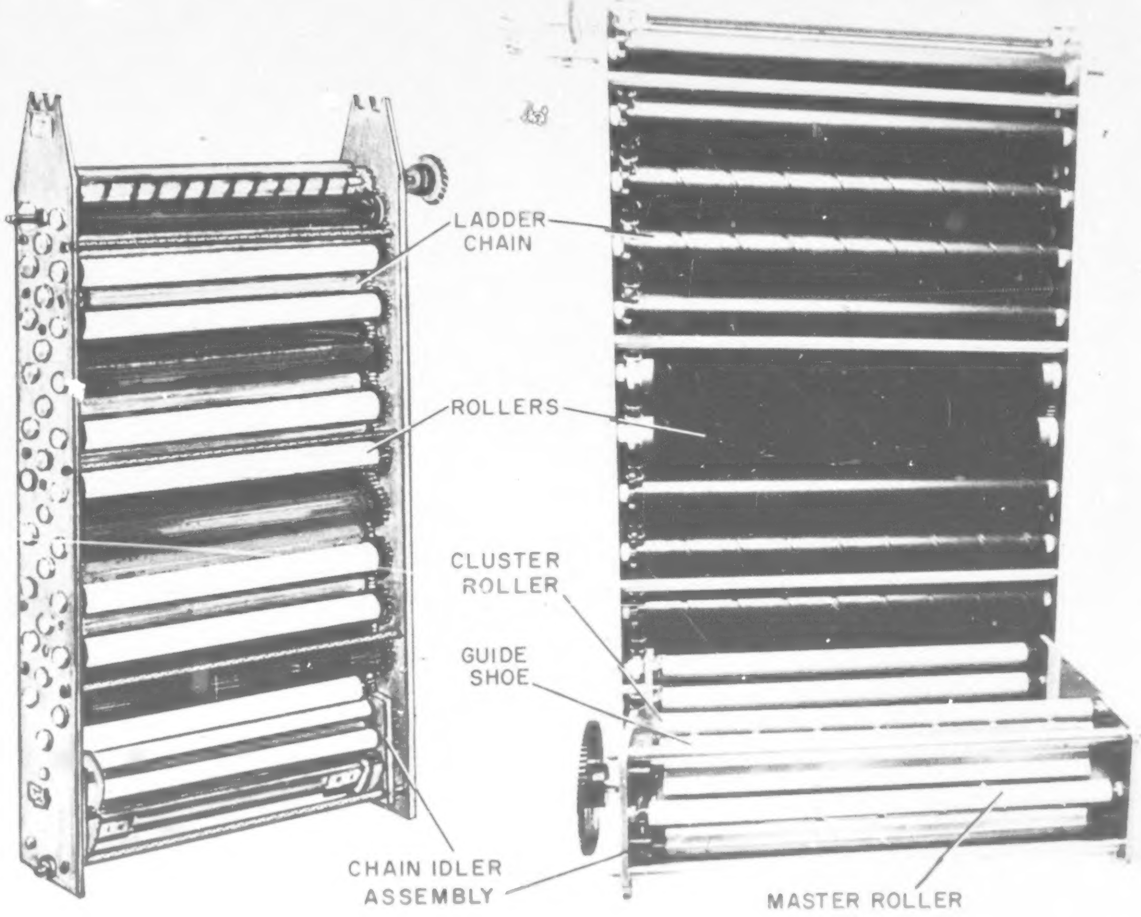
Main Drive

The film transport system is driven by a one-half horsepower, variable speed motor located beneath the multiroll squeegee. One chain drives the horizontal shaft, which drives the entire roller transport system in both the processing and the drying sections. A second chain drives the multiroll squeegee, with a third chain driving the detector rolls. A fourth and fifth chain are located in the dryer pressure plenum section. These chains drive the dryer entrance and dryer exit assemblies.


CROSSOVER
ROLLER RACK
MULTIROLL SQUEEGEE
DRYER ENTRANCE CROSSOVER
FILM FEEDING STATION
SOLUTION TANK
MAIN DRIVE MOTOR
DRYER PRESSURE PLENUM
DRYER EXIT CROSSOVER
RECEIVING BIN
DARK ROOM WALL PANEL
AIR TUBE
RACK TURNAROUND
FILM DRYER SECTION
REPLENISHER PUMPS
FILM PROCESSING SECTION
AIR BLOWER
TRANSPORT ROLLER
DRYER TURNAROUND

PH.414

Figure 7-2.—Roller-transport system.



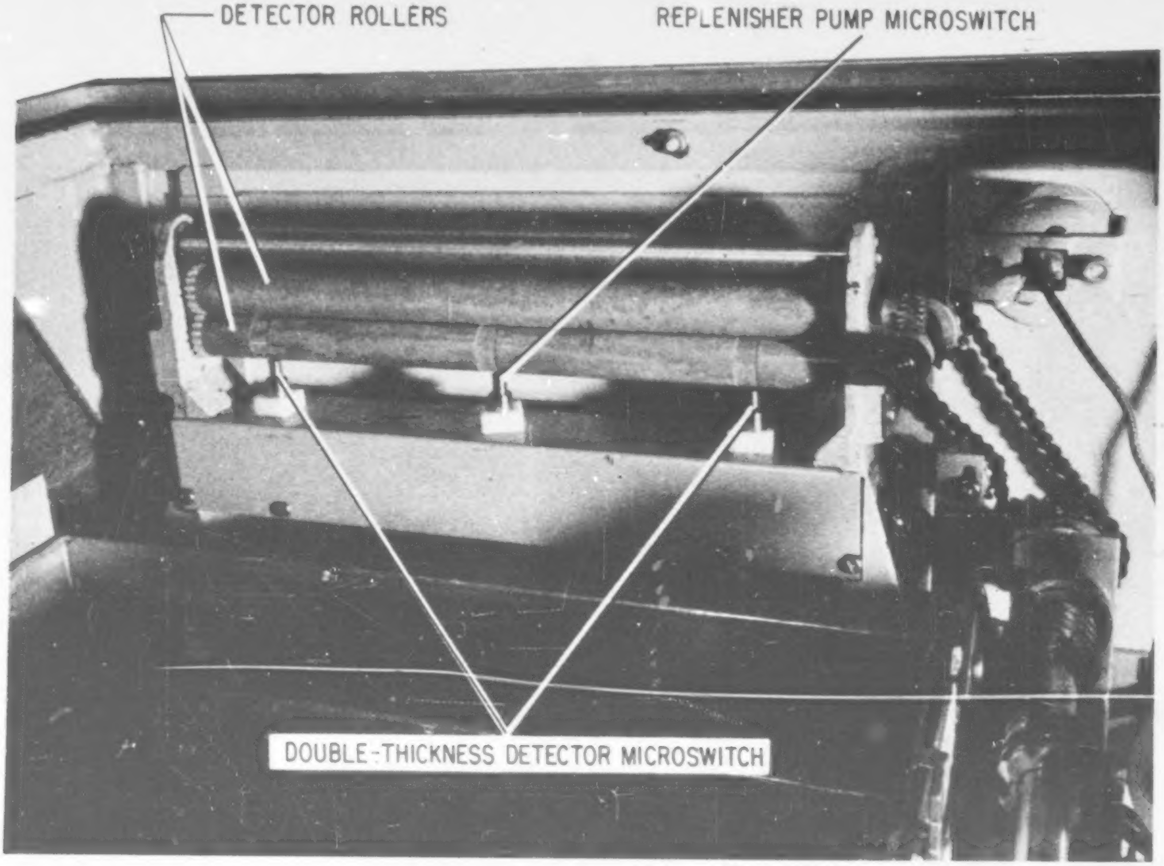
PH.415

Figure 7-3.—Rack and crossover assemblies. (A) Crossover; (B) roller rack; (C) spraywash rack.

The roller racks are driven by a series of worms, mounted on the main drive shaft. The dryer drive is also transmitted by means of a worm gear mounted on the main drive shaft. This worm gear drives a pulley, which drives the endless cloth belt.

The detector roller assembly consists of two rollers with three microswitches mounted beneath the bottom roller that activates a bell or buzzer. (See fig. 7-4).

The detector rollers are driven by a chain from the main drive shaft. The detector rollers supply initial drive to the film as it is fed into the processor. Should a double thickness of film, or a length of damaged film be fed into the processor, the microswitch at each end of the roller assembly will set off a buzzer. The center microswitch operates a timing relay which sounds a bell approximately 3 seconds after the trailing edge of the film or the end of the film has passed through the detector rollers. This sound or signal also tells the operator that he can feed in the next sheet of film when processing sheet film.


DETECTOR ROLLERS
REPLENISHER PUMP MICROSWITCH
DOUBLE-THICKNESS DETECTOR MICROSWITCH

PH.416

Figure 7-4.—Detection rollers and micro-switches.

NOTE: Always feed film into the processor emulsion side up.

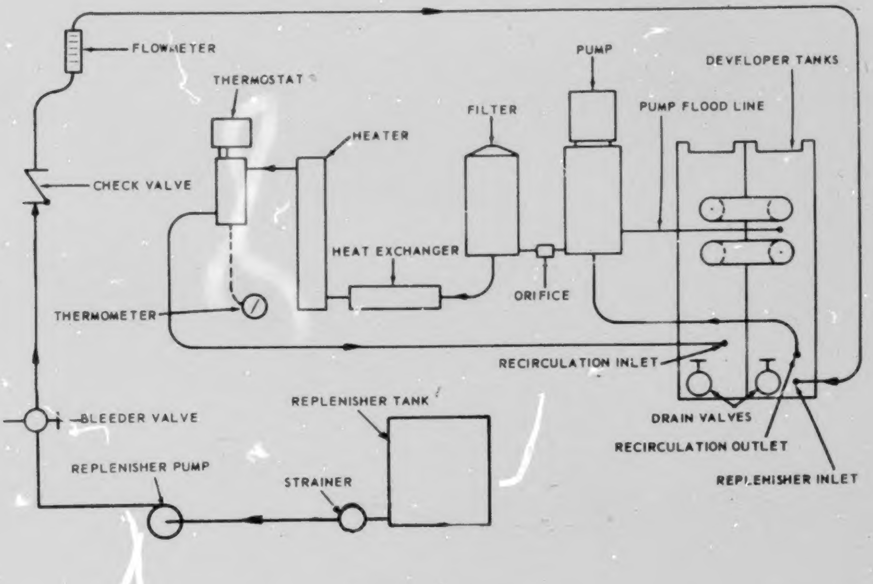
The center microswitch also actuates replenisher pumps into the auto mode of operation as the leading edge of the film enters the detector roller assembly.

Developer Recirculation

The developer recirculation system consists of a sump type pump which takes solution from the bottom of the No. 1 developer tank, passes it through a filter, heat exchanger, and heater, over a thermostat sensing element and thermometer probe, and into the bottom of the No. 2 developer tank. An orifice is provided on the pressure side of the pump to limit the developer flow to 2 1/2 gallons per minute.

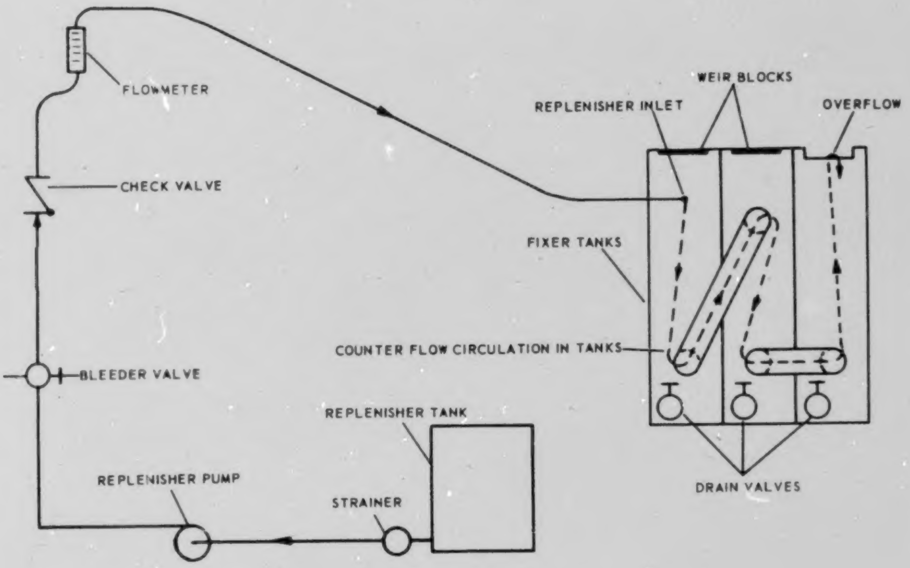
Replenishment Systems

The replenishment system consists of the following: two chemical storage tanks with holding capacities to 30 gallons each, two solution strainers, two replenishment pumps, two bleeder valves, two flow check valves, and two flow meters (calibrated in cc's, cubic centimeters). For location of the parts in the system and direction of flow, refer to figures 7-5, 7-6, and 7-7. It is of the utmost importance that accurate


FLOWMETER
THERMOSTAT
PUMP
DEVELOPER TANKS
FILTER
PUMP FLOOD LINE
HEATER
CHECK VALVE
HEAT EXCHANGER
ORIFICE
THERMOMETER
RECIRCULATION INLET
REPLENISHER TANK
BLEEDER VALVE
DRAIN VALVES
RECIRCULATION OUTLET
REPLENISHER PUMP
STRAINER
REPLENISHER INLET

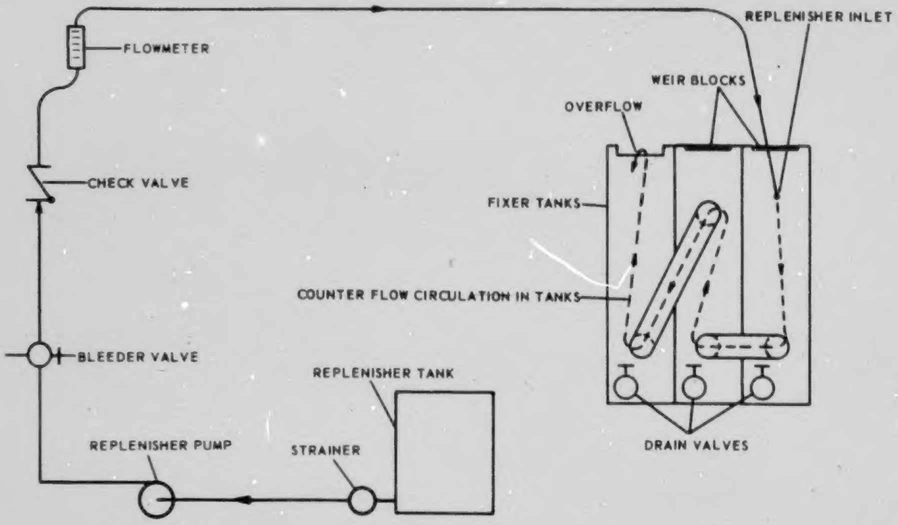
PH.417

Figure 7-5.–Developer replenisher and recirculation system; EH-38C processing machine.


FLOWMETER
WEIR BLOCKS
REPLENISHER INLET
OVERFLOW
CHECK VALVE
FIXER TANKS
COUNTER FLOW CIRCULATION IN TANKS
BLEEDER VALVE
REPLENISHER TANK
REPLENISHER PUMP
STRAINER
DRAIN VALVES

PH.418

Figure 7-6.–Fixer replenisher schematic for low contrast type chemistry; EH-38C processing machine.



PH.419

Figure 7-7.—Fixer replenisher schematic for high contrast type chemistry; EH-38C processing machine.

replenishment be maintained to keep individual solutions at their proper strength, thereby insuring the following:

1. Proper density and contrast.
2. Conditioning of film for increased transport reliability.
3. Increased solution life.

It should be noted that overreplenishment may cause higher film contrast, whereas underreplenishment can result in decreased contrast. Excessively low replenishment of the developer or none at all could result in the film sticking in the dryer.

FIXER REPLENISHMENT.—The fixer replenisher flow differs with each of the different types of film used. Figures 7-6 and 7-7 are diagrams of the replenishment flow for commercial and aerial films.

When commercial film is processed, the replenisher for the fixer is put into the final fixing tank, causing a flow that is counter to the direction of film travel. With aerial film, the replenishing solution for the fixer is directed into the first fixer tank with the flow of the fixer and film being in the same direction. This helps to maintain acidity of the fixer, especially in the first tank, and thereby maintain uniform processing results. Too much replenishment is only wasteful, yet underreplenishment will give poor fixation, poor hardening, and tends to cause inadequate washing. Underreplenishment could also lead to the film not being transported through the fixer rack and subsequent racks.

REPLENISHER PUMPS.—When the microswitch under the center of the detector rollers is actuated by the presence of film, 0.005 inch or more in thickness, the replenisher pumps are energized. For replenishment of solutions when processing thin base film, a MANUAL setting is provided on the replenisher pump switch.

For adjustment of the replenishment rate, which is critical, two direct-reading flowmeters are provided. These flowmeters (developer and fixer) indicate the rate of replenishment in cubic centimeters.

Air Circulation System

Makeup air is supplied to the dryer through a filter located in the removable dryer panel. A blower, driven by a 2-horsepower motor, is located beneath the processing section. The

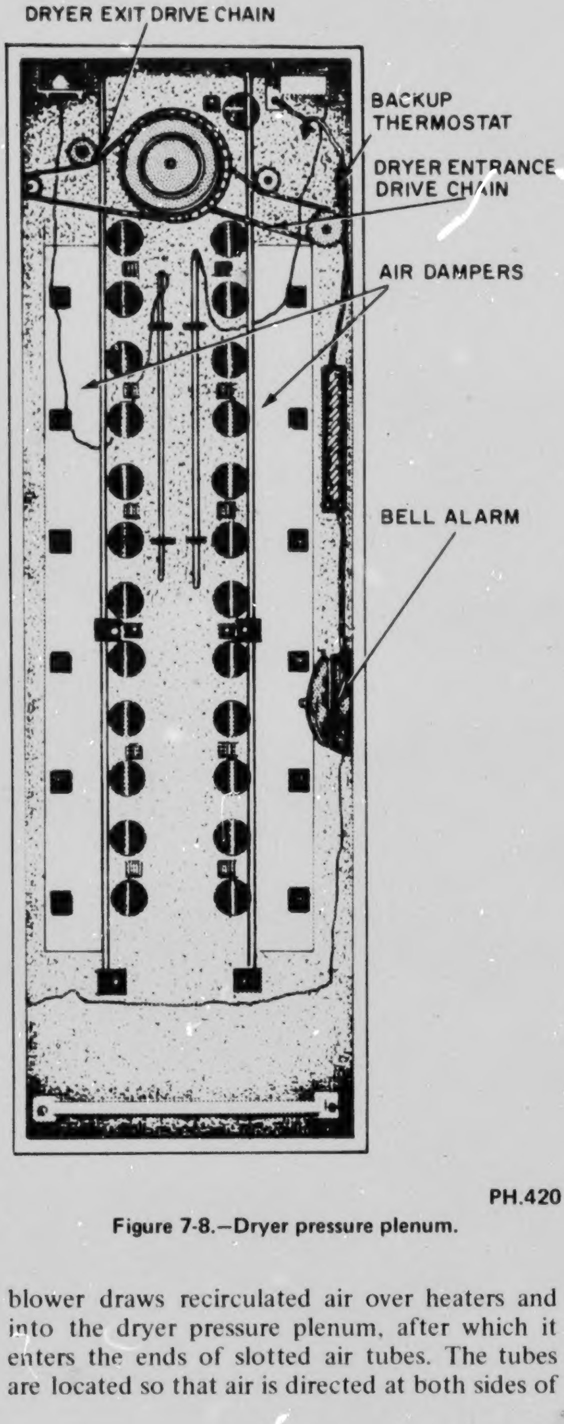


Figure 7-8.—Dryer pressure plenum.

blower draws recirculated air over heaters and into the dryer pressure plenum, after which it enters the ends of slotted air tubes. The tubes are located so that air is directed at both sides of the film as it is transported by the dryer roller system. (See fig. 7-8.)

A thermostat is located at the top of the dryer pressure plenum. A change in temperature of the circulating air activates the heater elements by means of the thermostat. Two adjustable air dampers control the amount of warm air admitted to the down-path and the up-path air tubes. The position of each damper is controlled by adjusting the damper control knob (fig. 7-9) from its closed position (0) to its open position (8). The processor is normally shipped with both control knobs set at the (2) position. (See fig. 7-9.)

Water Circulation

The water circulation system consists of a thermostatically controlled mixing valve, a thermometer, a heat exchanger, and a controlled orifice which effects a constant rate of delivery of 4 gallons per minute. This water is delivered at the selected temperature to the two spray racks within the wash tanks of the processor.

NOTE: The Versamat Processor can be modified to conserve wash water by reducing flow rates from 4 gallons per minute to 1/2 gallon per minute, the amount of fresh water required to wash most films in the Versamat. This reduction in water consumption is accomplished by using a combination deep-bath and spray wash system.

To dry the film successfully with minimum curl, it may be necessary to readjust the control knobs. The type of film being processed, the ambient conditions of the room, and the processor operating speed will govern the desired settings. As a safeguard, a high-limit backup thermostat (fig. 7-8) shuts off the heaters and sounds a bell alarm if, for any reason, the dryer reaches a temperature of approximately 150° F or higher. The bell alarm will stop ringing when the dryer temperature drops below 150° F. The moisture-laden exhaust air must be piped from the processor into duct work and directed from the building.

Make sure the speed control knob is turned off (fully counterclockwise). Turn on the dryer fan, main drive, and developer recirculating pump switches. Press the replenisher pump switch to AUTO. For processing continuous

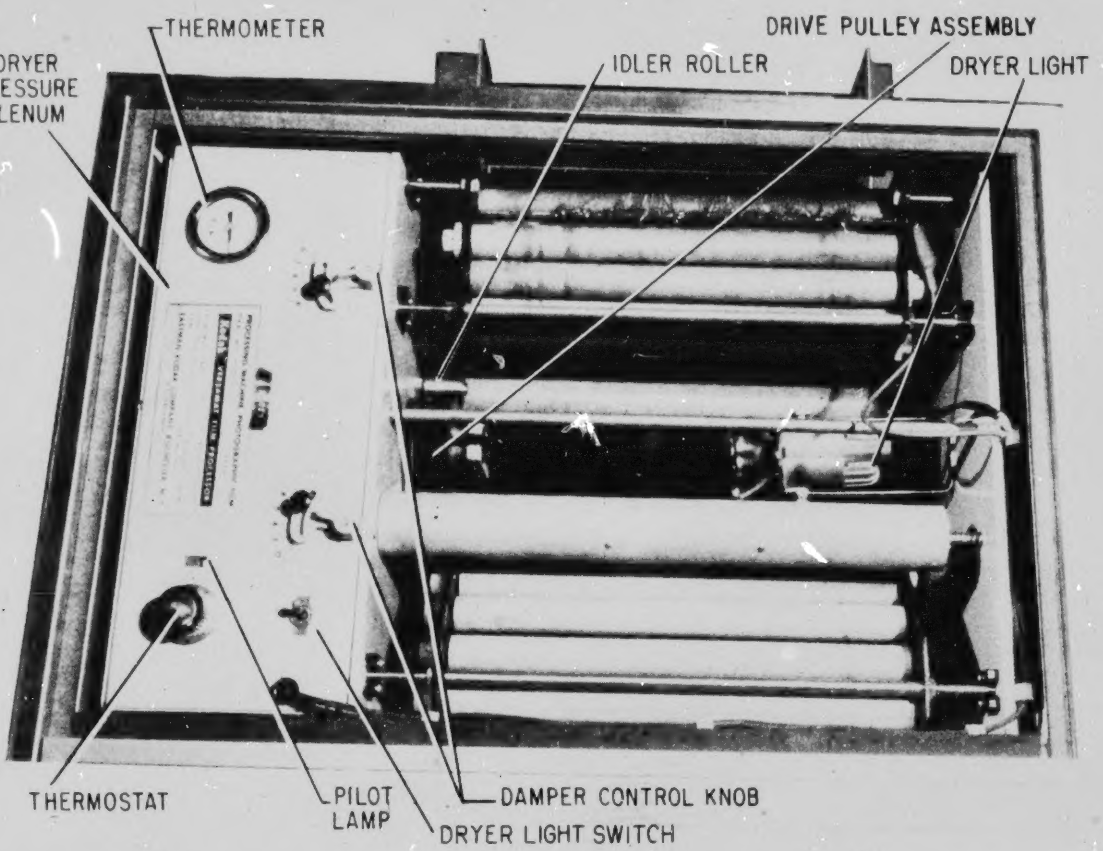

THERMOMETER
DRYER PRESSURE PLENUM
IDLER ROLLER
DRIVE PULLEY ASSEMBLY
DRYER LIGHT
THERMOSTAT
PILOT LAMP
DAMPER CONTROL KNOB
DRYER LIGHT SWITCH

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Figure 7-9.—Dryer indicators and controls.

lengths of thin base film, press this switch to MANUAL.

CAUTION: DO NOT ADJUST MACHINE SPEED UNTIL THE MAIN DRIVE HAS OPERATED AT LEAST 6 SECONDS; OTHERWISE, A POWER SURGE TO THE MAIN DRIVE COULD CAUSE DAMAGE.

Processing data sheets are available for the processor. Refer to the data sheet that covers the type of film to be processed. Adjust the processor speed; the temperature of the developer, dryer, and wash water; and the replenishment rates as recommended.

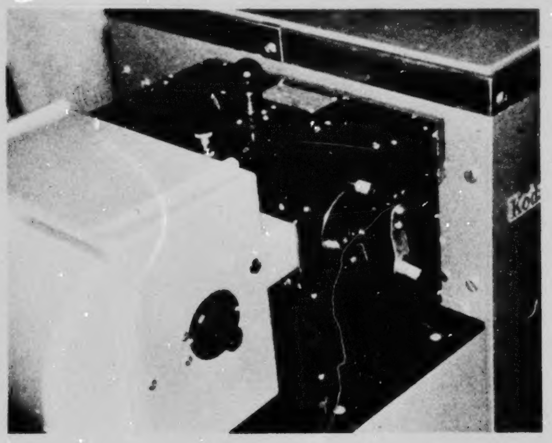
Electrical

The processors are supplied with a transformer to operate on a 240-volt, 3-phase, 3-wire, 60-Hz service. Maximum power requirements are 50 amperes per leg and a total power of 14 kw. The processor must be grounded by means of the ground strap that is furnished with each machine. The processors equipped as described above are special radio frequency interference suppression models.

The processor is equipped with the following controls for regulating its operation: main drive switch, dryer fan switch, replenisher pump switch, developer recirculation pump switch, speed indicator light switch, dryer light switch, and a double thickness alarm.

Supply/Takeup Assemblies

The rollfilm/paper supply assembly with film/paper magazine (fig. 7-10) and takeup assembly



PH.422

Figure 7-10.–Magazine and feed adapter.

are used to supply aerial rollfilm or paper, in a light-tight magazine, to the processor and to provide a means for taking up rollfilm on aerial film spools or paper on wooden cores.

Figure 7-11 shows the takeup assembly which consists of a table that mounts on the dryer end of the processor. This table has two drive rollers that provide peripheral friction to the flanges of the takeup film spools. To accommodate for the differences in the processing speeds and the buildup on the takeup spools, one of the drive rollers has been provided with a quick disconnect so that it can serve as an idler roller when desired. Also, the diameters of the different flanges have been varied to provide additional control for changing the rate of the takeup speed.

There are two sizes of flanges, as shown in figure 7-12; these are 8-inch diameter and 11-inch diameter both of which have been provided with quick snap-ons to insert into the standard aerial film spools, thus permitting direct winding of the film onto the spool as the film comes out of the processor. Another 11-inch-diameter flange is designed to accept the wooden core which is standard for 500-foot lengths of paper.

OPERATION

Procedures for processor operation (provided that daily startup procedure has been accomplished) are as follows:

1. Turn on both the main power safety disconnect switch and the outside water source.

2. Before turning the main drive switch ON, insure that the speed control dial is turned all the way to the DECREASE position. Turn on the dryer fan, main drive, and developer recirculation pump switches.

CAUTION: Do not adjust machine speed until the main drive has operated at least 30 seconds; otherwise a power surge to the main drive could result in damage. Press the replenisher pump switch to AUTOMATIC for sheet films. For processing thin base film, press this switch to MANUAL when starting the film through the processor.

3. Processing data sheets are supplied with the processor. Refer to the data sheet covering the type of film to be processed. Adjust the processor speed; the temperature of the developer, dryer, and wash water; and the replenishment rates as recommended.

4. Adjust the developer and fixer flowmeters by turning the replenishment control valves, with the replenishment switch in the MANUAL position.

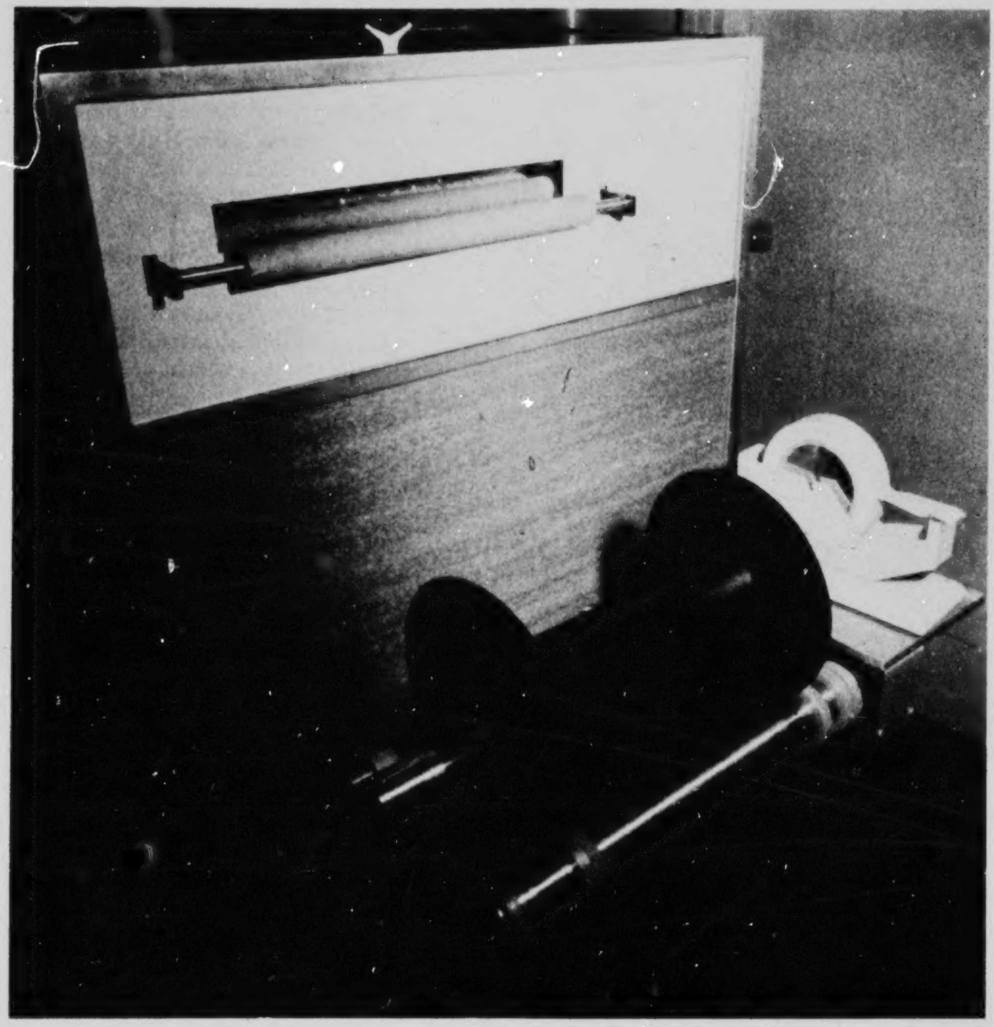
5. After the developer and the dryer have reached the recommended temperature, process a sensitometric strip to insure that the processor is in control.

6. When it is established that the processor is in control, normal processing can begin.

7. Always feed film emulsion side up. Be sure the edges of the film are square with the side edges of the feed tray adapter, then advance the film until it is drawn into the processor by the rotating detection rollers. Do not feed film less than 5 inches long into the processor.

8. Figure 7-13 shows the proper feeding procedure for sheet film. The arrow indicates the direction in which the film is fed into the machine.

Whenever it is possible, feed all strands of film side by side to avoid excess usage of the solutions. This will aid in balanced replenishment



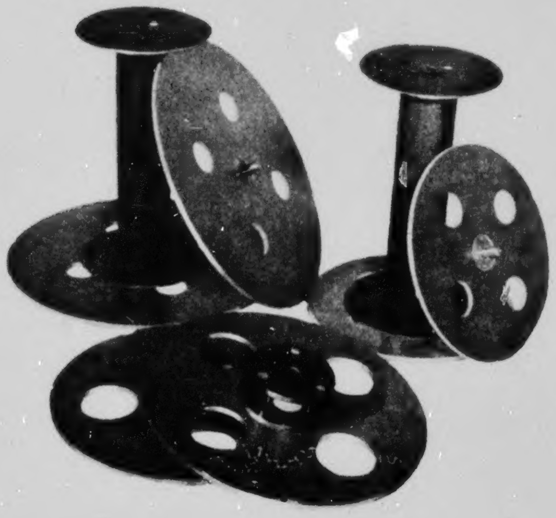
PH.423

Figure 7-11.—Roll takeup adapter.

and will result in maximum economy of solutions used, in addition to savings in time and water. Some examples are as follows:

16mm–4 strands
35mm–4 strands
70mm–3 strands
90mm–2 strands
5¼ to 9½ x 1,000 feet–1 strand
5 inches any length–2 strands

9. To insure proper transport of rollfilm, it is necessary to use a stiffening tab, such as a sheet of clear acetate. This tab is to be cut 7 inches long and 2 inches wide when used with 16mm or 35mm film. With 70mm or 5-inch film, the tab should be as wide as the film and 7 inches long. Use 1-inch width, pressure-sensitive tape, such as Scotch Brand No. 471 or equivalent, to fasten the tab to the film. Use a butt splice and



PH.424

Figure 7-12.—Film and paper flanges.

be sure the adhesive side of the tape is not exposed.

10. Upon completion of processing, turn all switches OFF, except dryer fan, main drive, and main power safety disconnect switches. Run the machine at approximately 8 feet per minute until the dryer temperature is 110° F or less. This will keep the dryer belt moving and prolong belt life. Turn off the water and clean the processor before leaving the area.

MAINTENANCE

A positive maintenance schedule should be set up and strictly adhered to. The following maintenance should be performed:

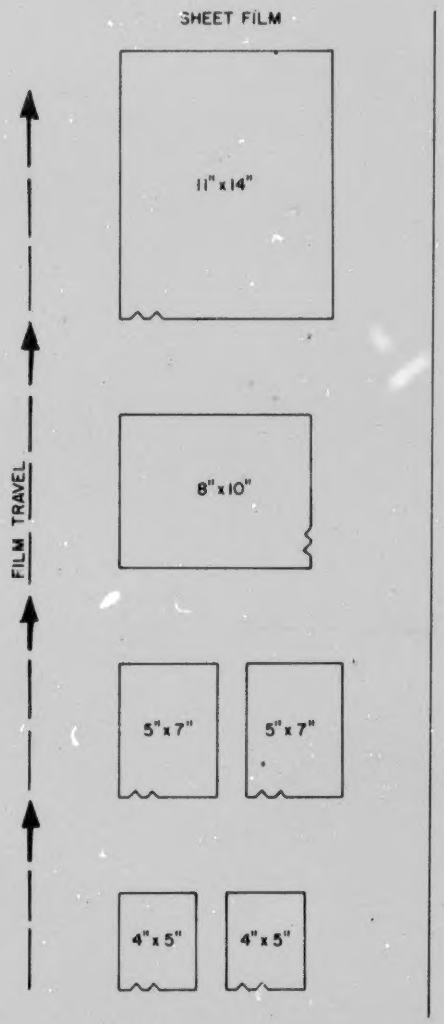
1. DAILY STARTUP PROCEDURE

a. Turn on the main power switch and the water supply.

b. Turn on the dryer fan, main drive, and developer recirculation pumps.

c. Set the replenisher pump switch to MANUAL and verify replenisher flow through the flowmeter. Set the replenisher pump switch to AUTO.

d. Remove the processing section cover and wipe down the entrance rollers and crossovers.



PH.425

Figure 7-13.—Feeding procedures for sheet film.

e. Feed test film through the machine and verify that the flow rate in MANUAL and AUTO agree. Verify that the film is not damaged or scratched by the machine. The first few films through the processor may be somewhat dirty on the surfaces as they come out. This is due to dirt pickup from the rollers and disappears as more film is run through. The best way to alleviate this problem is for the operator to feed a few sheets of 8 x 10 test film each day when the processor is turned on for the first time. A more convenient method is to run about 15 feet of 9 1/2-inch aerial film through instead of the sheet film. This film will pick up the dust and other foreign matter accumulated during the nonoperational period. This processed film will also show any scratches due to bent guide pins or foreign matter permanently embedded on the rollers. Scratch tests should be run until any discrepancy is eliminated.

f. Check the operation of the racks and crossovers.

g. Check the multiroll squeegee for seating and operation and the entrance and exit crossovers in the dryer.

h. Check the temperatures of the developer.

i. Check the temperature of the dryer.

j. Check the settings of the damper.

k. Replace covers.

l. Evaluate a processed control strip.

2. DAILY SHUTDOWN PROCEDURE

Where a processor is operated on a round-the-clock basis, steps a through c of the procedure listed below should be followed once each 24 hours.

a. Remove, and rinse with warm water, all processing section crossover assemblies. Remove any deposits that may have accumulated with a soft brush. These assemblies should be handled carefully to prevent throwing them out of square.

CAUTION: Care must be exercised to prevent catching loose clothing, fingers, or any foreign material in the moving gears.

b. Wipe all rollers above the solution level without removing the racks from the processor.

c. Clean the feed rollers at the entrance roller assembly.

d. Determine that the processor has been cleared of film.

e. Leave the dryer fan operating and shut off power to the other systems at the processor control panel.

f. Turn off the water supply and allow the dryer to cool to 110° F, then turn off all switches at the control panel and turn off the main power switch.

g. To allow the escape of the chemical-laden fumes from the processing tanks, prop the covers of the processing and drying sections open. This procedure will help to prevent the staining of parts in the machine.

3. WEEKLY PROCEDURE

a. Remove and clean all crossover assemblies with a damp cloth or vinyl sponge.

b. Check rack chain tension. Roller hesitation indicates a possible loose chain.

CAUTION: Put the splash guard in place on the partition between the developer and fixer tanks, to prevent the contamination of the developer with fixer when removing the fixer racks.

c. Remove roller racks and rinse with warm running water not exceeding 120° F. Then wipe with a damp cloth or vinyl sponge, making sure that all deposits of chemical are cleaned off the sides of the racks around the chain tighteners and gears.

d. To be certain that all rollers turn properly, rotate the rack manually. If required, the chain tension should be adjusted.

e. Determine if the rack is twisted out of square by placing it on a flat surface.

f. Check for recirculation, with the pumps in operation, by observing the solutions in the tanks.

g. With the racks out, examine the solutions for foreign substances and clarity.

h. Replace racks and crossovers and check gears to make certain that all are seated properly.

i. Inspect the multiroll squeegee as well as the crossovers at the entrance and exit of the dryer for proper seating.

j. Check the dryer air intake screen and air tubes for obstructions. For cleaning instructions, refer to the Kodak Versamat Service Manual.

4. MONTHLY PROCEDURE

a. Drain all chemicals and clean entire machine and chemical tanks. Flush all tanks with fresh water.

NOTE: If effective quality assurance procedures are employed, it is not necessary to drain all chemicals monthly. Even though the chemicals will last indefinitely with proper replenishment, the machine should be drained every 3 to 6 months for cleaning and inspection. The time interval will depend on machine usage.

b. Clean dryer filter.

c. Replace the developer filter or, when a permanent-type filter is used, clean.

d. Check the replenisher and thickness detection microswitches for proper operation.

e. Time the developer worm gear hub for 1 minute to determine the speed of the processor. To obtain the exact processing speed, multiply the number of revolutions by 0.262.

f. Clean the developer and fixer strainers.

g. Check overall condition of the processor.

When switching from one developer to another, the developer filter must be changed. If there is no change in the type of developer, the filter should be replaced monthly or after each 20,000 feet of film processed. It should also be replaced whenever the tanks are cleaned.

For complete information on installation, operation, and maintenance of the EH-38C film processor, refer to the manufacturer's instructions manuals furnished with each processor and to the pertinent Photographic Technical Bulletins, NavAir 10-1TB-(Series). The following training films are also recommended:

1. MN-10302A—EH-38 Film Processor, Operation and Maintenance.
2. MN-10302B—EH-38 Film Processor, Maintenance.
3. MN-10302C—Film Processor, Quality Assurance.

RACK WASHERS

Rack washers have been designed for the thorough cleaning of the racks used in the EH-38, EH-66 and EH-73 processors. These rack washers eliminate the need to use dangerous, messy, and time consuming system cleaners for the cleaning of the racks. One such rack washer is the Versa Wash, models 54102A and 54102AR, manufactured by Welded Products, Inc. The operating precautions, operating procedures, and maintenance of the Versa Wash are discussed in the following paragraphs.

Operating Precautions

When the spray system is being operated, the plastic lids must always be in place. Use the two latches on each lid to lock them down. The solution reservoir should be checked before use to insure that it is filled to the proper level. The wash solution pump must never be operated if the solution reservoir is dry. When changing racks, the rack drive motor must be in the OFF position. Before the drive motor is started, be certain that the gears on the processing rack are correctly meshed with the worm gear on the rack washer. To insure that the gears fully mesh, adjust the rack supporting gears vertically. The weight of the rack should be carried by the supporting guides, not the gears.

Make certain that the gears and rollers are free to turn before placing the rack into the washer. The drive motor will stall if the rack is "jammed" and possible damage to the rack can result.

Mix the Versa/Cleaner solution according to the directions packed with the cleaner in a separate container. Fill the bottom reservoir to maximum capacity (10 to 12 gallons) by pouring the wash solution into the front tank. The tank is full when the fluid level is 1/2 inch below the screen visible at the tank bottom.

Operating Sequence for Rack Washer

Insure that the rack gear properly meshes with the worm gear of the drive motor while lowering the rack to be cleaned into position in the wash tank. Turn on the drive motor. If the red pilot light next to the drive motor switch is illuminated, the rack is being properly driven.

Place the plastic lid on the tank and secure it by engaging the two latches. The latches are engaged by turning them clockwise until they pull slightly. Turn on the pump motor. If operating properly, the pilot light next to the switch should be illuminated.

Follow the Versa/Cleaner instruction sheet in timing the solution spray duration. The duration of the solution spray will be approximately 5 to 10 minutes. Switch off the pump and drive motor switches after the timing cycle has been completed.

NOTE: Never open the lid while the solution spray is on.

After the solution spray has stopped, allow the rack to drain for about 1 minute. Then lift the rack out and lower it into the rear soak and rinse tank. While the first rack is being soaked and rinsed in the rear tank, a second rack can be cleaned in the front wash tank.

NOTE: The reservoir must be flushed with clear warm water when the cleaning solution is drained. Do not store the unit until the cleaning solution has been drained and the reservoir flushed.

Operating Procedure for Neutralizing and Rinsing

Close the "quick dump" valve by pushing the lever at the inside top of the tank to the rear. Turn on the drive motor, insuring that the gears are properly meshed. Adjust the temperature of the rinse water to approximately 70° to 80° F and fill the tank to the top of the overflow tube.

Add the Versa/Neutralizer solution to the tank and allow the driven rack to soak for 3 to 5 minutes. The correct amount of solution to use will be found in the instructions packed with the solution.

NOTE: It is normal for a slight amount of solution to leak from the "quick dump valve." During this time the fluid level will not drop enough to affect the neutralizer action.

Move the lever toward the front and open the "quick dump" valve. Then reopen the rinse water valve to start the rinse cycle. Shut off the rinse water after the rack has been properly rinsed and allow the rack to drain.

Rack Washer Maintenance

When the filter cartridge is dirty or spray volume reduction is apparent, replace the cartridge. Occasionally wipe a thin coat of grease on the roller drive chain.

Unscrew and clean or replace the spray nozzles when they become clogged. The "flat spray" nozzles are for use only in the top pipe. When the slot is in the horizontal position, they are properly alined.

After every third or fourth solution change, fill the solution reservoir with clean, warm water, start the pump, and flush the solution out through the drain.

PROCESSING MACHINE TYPE EH-66

The EH-38 processor filled the need for a dependable, high quality processor for large shipboard and shore-based photographic laboratories. There still existed the need for a similar machine for the small shipboard and shore-based labs. The mobile photographic laboratories also required a machine that was smaller, lighter, and of lower output rate. The Naval Photographic Center and Eastman Kodak Company, together, designed and produced the EH-66 processor (fig. 7-14 and 7-15), to meet the needs of the smaller laboratories. It closely paralleled the EH-38 but the size was reduced and the output was approximately halved.

The chemical solutions used in the EH-66 are the same as those used in the EH-38 processor.

To get an idea of the physical dimensions and the capacities of the EH-38 and EH-66 processors, study table 7-1.

EH-73 COLOR PROCESSING

The Kodak Ektachrome RT processors, RT 1411-M and RT 1411A-M, military designator EH-73A; and RT 1811A-M, military designator EH-73B, are designed for the rapid processing and drying of certain Kodak Ektachrome roll film, in sizes up to 9 1/2 inches wide, and color duplicating films.

The EH-73A processor (fig. 7-16) consists of two 7-tank wet sections and one drying section of the black-and-white Versamat C (EH-38) coupled to form the 14-tank EH-73A.

The EH-73B processor is similar in appearance to the EH-73A with the exception that the control console for the EH-73B is not wall mounted. Also, the EH-73B, a Kodak RT 1811A-M processor, has 18 tanks rather than 14 and is proportionately longer than the EH-73A.

Maximum processing speed for the EH-73A with the speed-up modification kit installed is 5.4 feet per minute, vice 9 feet per minute for the EH-73B. This results in an access time of nearly 12 minutes for the EH-73A processor; a 250 foot roll of aerial film will take approximately 46 1/2 minutes to process.

Table 7-2 indicates features of the EH-73A processor, and table 7-3 indicates features of the EH-73B processor.

The EH-73 processors use an EA-5 chemistry process supplied in proprietary kits from the Eastman Kodak Company. Processing

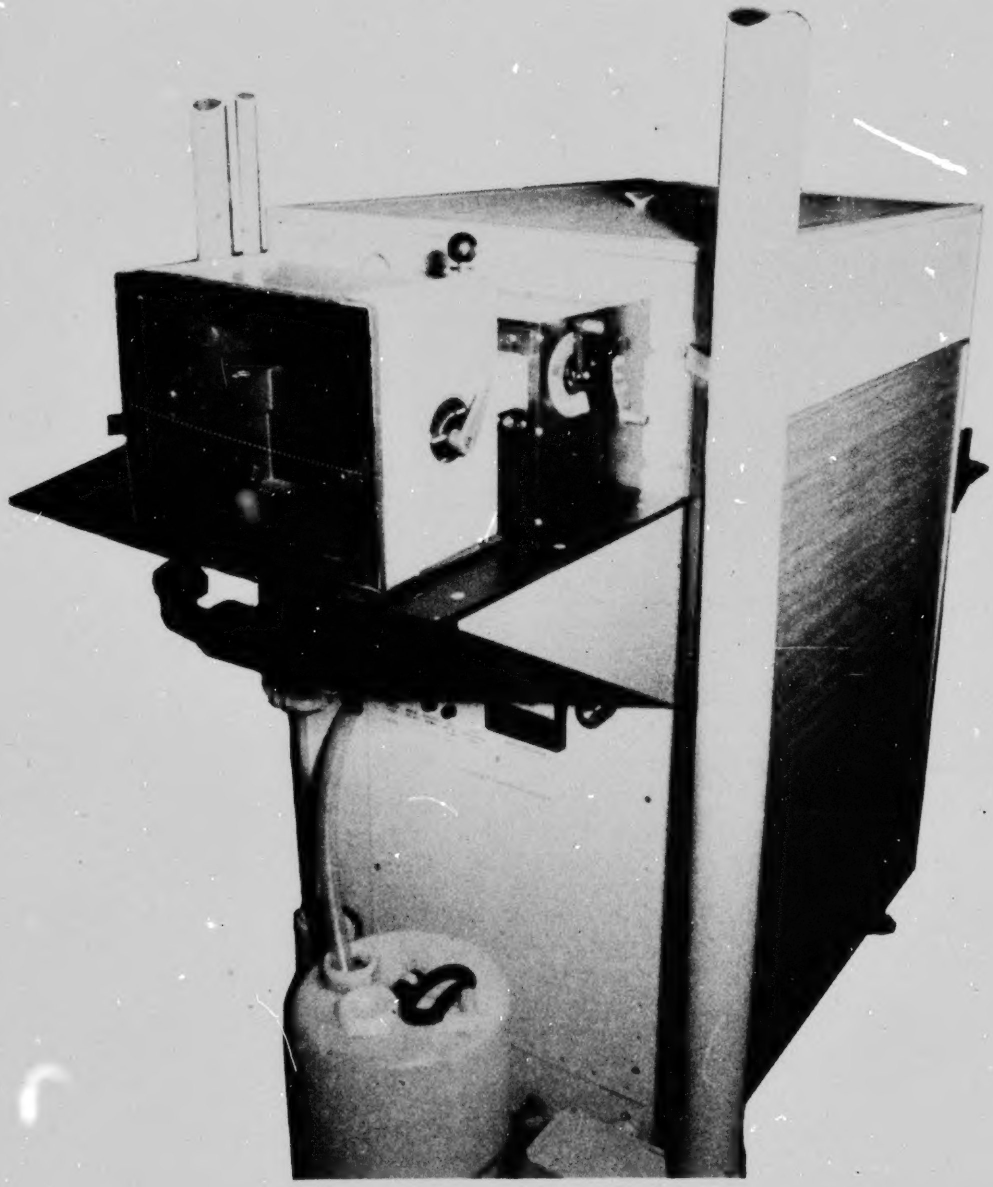


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Figure 7-14.—EH-66 processing machine, supply end.

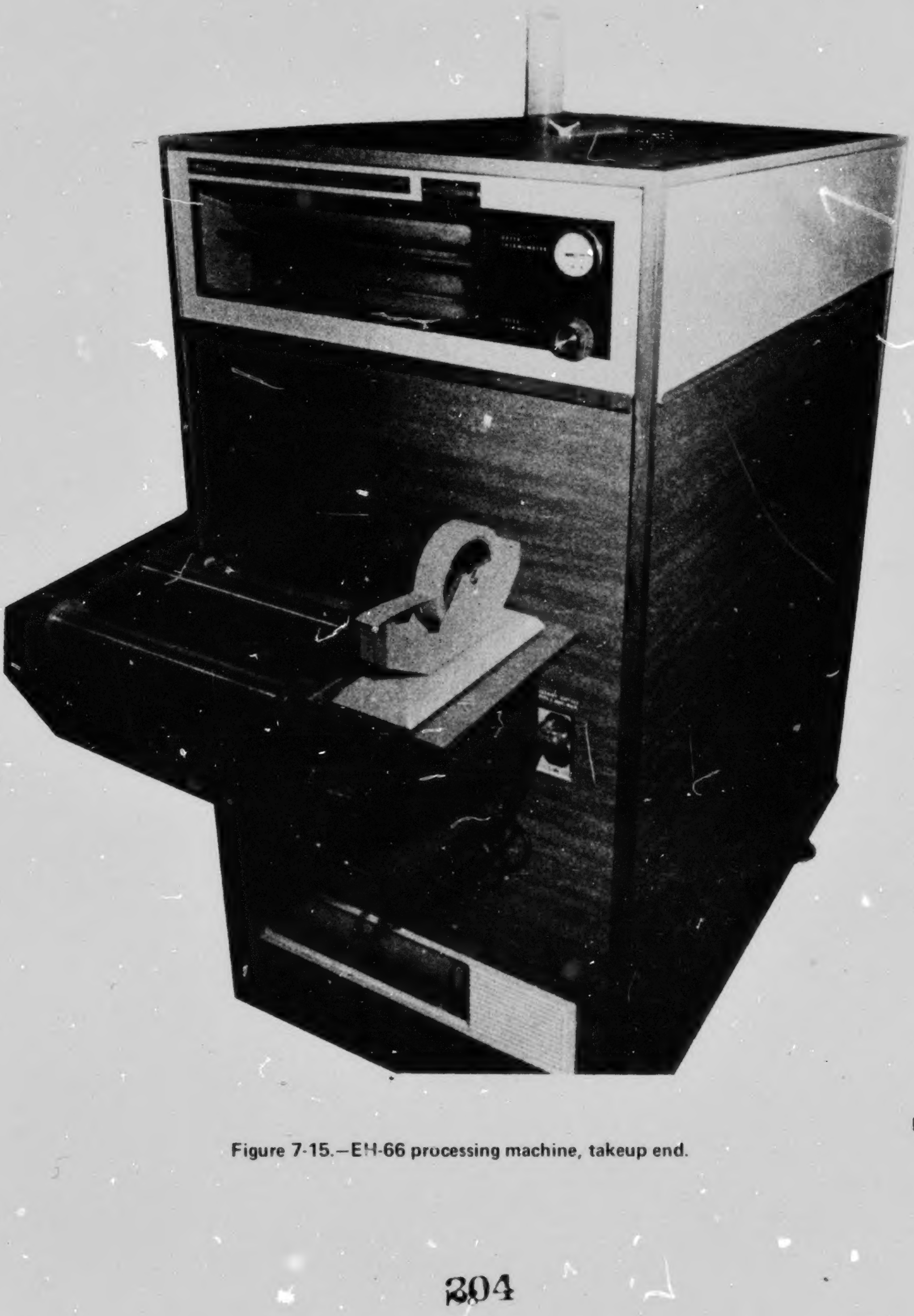

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Figure 7-15.—EH-66 processing machine, takeup end.

Table 7-1.–EH-38/EH-66 comparative characteristics.

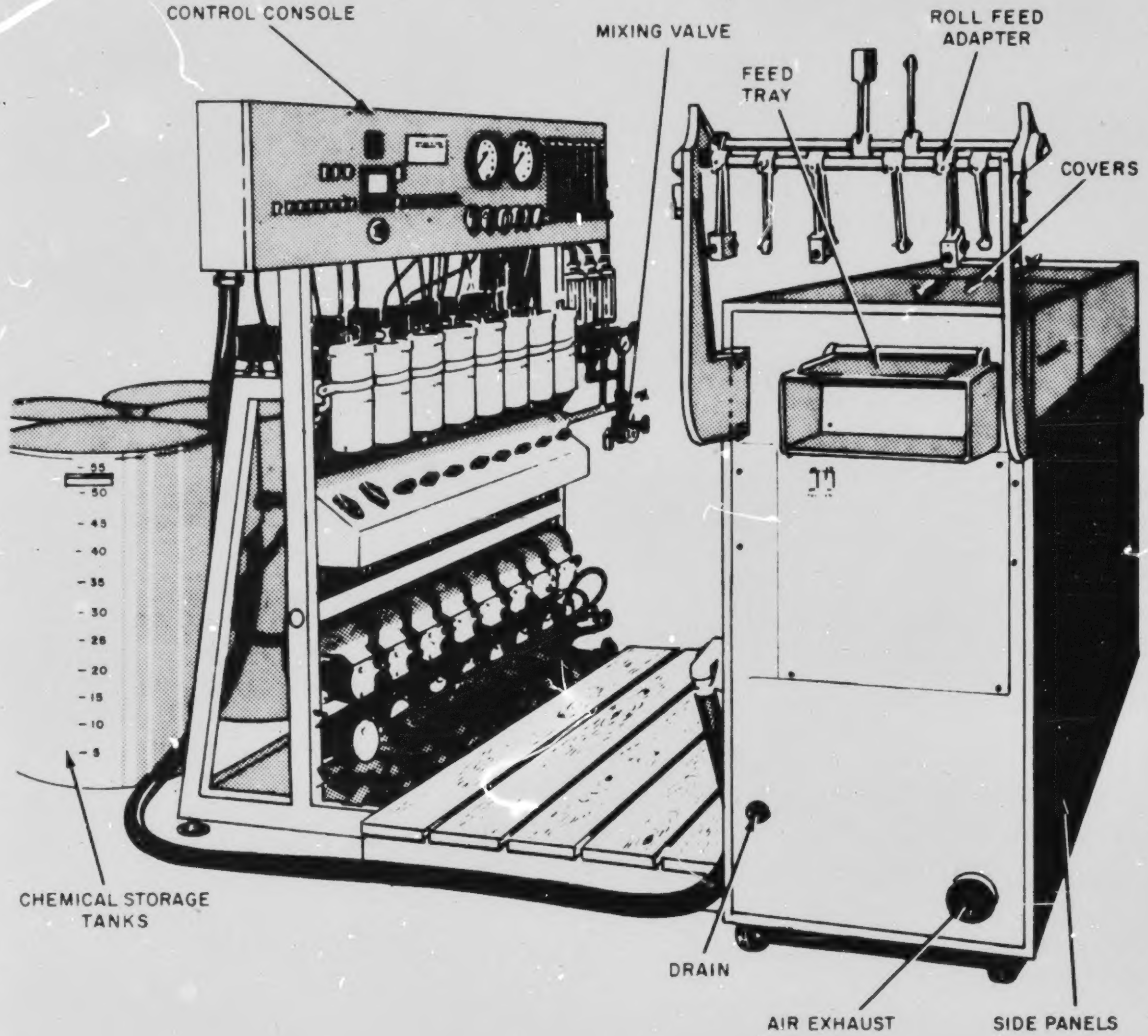
<table>
<tr><th>EH-38</th><th>EH-66</th></tr>
<tr><td colspan="2">Dimensions in inches
(Dimensions are with aerial rollfilm adapters mounted.)</td></tr>
<tr><td>Length 89
Width 25½
Height 63½</td><td>Length 68
Width 25½
Height 63½</td></tr>
<tr><td colspan="2">Solution tanks
(4½ to 5 gallons per tank)</td></tr>
<tr><td>Developer 2
Fixer 3
Wash 2</td><td>Developer 1
Fixer 2
Wash 1</td></tr>
<tr><td colspan="2">Usable drive rate
(feet per minute)</td></tr>
<tr><td>5" to 25' (All speeds below 5' per minute are erratic)</td><td>3" to 15'</td></tr>
<tr><td colspan="2">Water requirements (per minute) (Both machines require 45 psi or 4 gallons per minute for spray washers or 2 gallons per minute for immersion washers.)</td></tr>
<tr><td>4 gallons</td><td>2 gallons</td></tr>
</table>

temperatures are dependent upon the type of film being processed and the chemical solution.

The EH-73 processing system is composed of three basic components; the processor, control console, and chemical storage tanks (fig. 7-16). These three components will be covered in the following section of this chapter.

EH-73 PROCESSORS

The EH-73A processor uses nine solutions and requires nine replenishers. However, the same type of chemical solution and replenisher is used for both the first and second stop baths so only eight different types of chemicals and replenishers are required. These eight different chemicals are contained in 11 of the processor's 14 tanks. Two tanks each are used for the prehardener, first developer, and color developer. The remaining five chemicals each occupy a single tank. The remaining three tanks are utilized as immersion wash tanks, tank 14 being an immersion wash tank with the stabilizer added.


CONTROL CONSOLE
MIXING VALVE
ROLL FEED ADAPTER
FEED TRAY
COVERS
55
50
45
40
35
30
25
20
15
10
5
CHEMICAL STORAGE TANKS
DRAIN
AIR EXHAUST
SIDE PANELS

PH.428

Figure 7-16.—EH-73A color film processor with chemical control panel and chemical storage tanks.

The EH-73B uses nine solutions and requires nine replenishers. However, like the EH-73A, the same type of chemical solution and replenisher is used for both the first and second stop baths so only eight different types of chemicals and solutions are required for the EH-73B. These eight different chemicals are contained in 15 of the processor's 18 tanks. Four tanks are used for the color developer, three tanks for the first developer, two tanks for the prehardener, and the remaining six chemicals each occupy a single tank. The remaining three tanks (eight, fourteen, and seventeen) are utilized as immersion wash tanks. The stabilizer is contained in a separate

Table 7-2.—EH-73A. Materials handled and solution arrangement.

Film size	Aerial roll film up to 9½ inches wide; 1,000 ft long.
Kind	2443, 2448*, 3443, 8442, SO-118, SO-180, SO-271, SO-360, SO-397, SO-121, SO-278.
Chemistry kit	EA-5
Film distribution Through path footage	61 feet wet section; 53 feet dry section
Tank/solution arrangement	Tanks: 1 & 2, prehardener; 3, neutralizer; 4 & 5, first developer; 6, first stop; 7, wash; 8 & 9, color developer; 10, second stop; 11, wash; 12, bleach; 13, fixer; 14, wash.**
Dryer	Heat load 10,000 BTU

*Use processing specifications on 2448 for processing High Speed Ektachrome and Ektachrome X.

**Insert Kodak EA-5 stabilizer and replenisher in final wash, tank 14, at the rate of 50 milliliters a minute, regardless of film size.

tank (eighteen) in the EH-73B processor and not combined in the final wash tank like the EH-73A.

The EH-73 processors require a water supply with a minimum pressure of 45 lbs per square inch (psi) of hot and cold water at the mix valve while flowing at a minimum rate of 6 gallons per minute, at the discharge side of the mixing valve. The water supply must also be able to provide hot water at a minimum temperature of 140° F and cold water at a maximum temperature of 110° F. One drying section is provided. (See fig. 7-17 and 7-18.)

Surface moisture is removed from the film before it enters the drying section of the processor by a multiroll squeegee. The squeegee is located between the exit crossover of the processing section and the entrance crossover of the dryer section. A single air tube is also located at the dryer entrance crossover to assist in the removal of surface moisture, as shown in figure 7-19.

A series of air tubes mounted between the transport rollers dries the film by directing an air flow to both the base and emulsion side of the film as it passes through the dryer.

EH-73 Main Drive System

Film is continuously moved through the processor by the main drive system, which is driven by a 1/2 horsepower, variable speed electric motor. A horizontal drive shaft driven by a chain from the main drive motor provides the drive for the entire system. A second and third chain from the drive shaft turns the multiroll squeegee and the detector rollers. A series of worm gears, attached by set screws to the drive shaft, drive the roller racks. Power for the dryer drive is obtained from the drive shaft which, by means of a worm gear mounted on a pulley arrangement, drives an endless belt that moves the rollers in the dryer section.

EH-73 Electrical Controls

The electrical controls for the EH-73 and their functions are as follows:

Table 7-3.—EH-73B processor and process specifications.

Processor speed is 9 feet per minute for all recommended films. The outline below gives the solution sequence and the time, temperature, and replenisher rate for each solution. Full information on preparing working solutions and replenishers is given in the section, "Mixing and Handling Chemicals."

Rack	*Solution*	*Time*	*Temperature*	*Replenishment Rate (ml/sq ft)*
1 & 2	Prehardener	0'53"	115 ± 1° F	60
3	Neutralizer	0'27"	115 ± 2° F	60
4, 5, & 6	First Developer	1'20"	*	*
7	First Stop	0'27"	115 ± 2° F	225
8	Wash (Immersion)	0'27"	115 to 125° F	(2 gal/min)
9, 10, 11 & 12	Color Developer	1'47"	120 ± 1° F	225
13	Second Stop	0'27"	120 ± 2° F	200
14	Wash (Immersion)	0'27"	115 to 125° F	(2 gal/min)
15	Bleach	0'27"	125 ± 2° F	120
16	Fix	0'27"	125 ± 2° F	120
17	Wash (Immersion)	0'27"	115 to 125° F	(2 gal/min)
18	Stabilizer	0'27"	Equilibrium**	120
	Dryer	0'53"	145 + 5° F	

All solutions are recirculated and filtered.

*First Developer temperature and replenishment rate vary, depending upon the film product to be processed. See the Machine Processing Data Release for a particular film.

**No temperature–controlling device is provided. Solution temperature attains "equilibrium" (dependent upon temperature of replenisher and surroundings).

NOTE: Table 7-3 is used by permission of the Eastman Kodak Company.

1. The main drive switch is located in front of the processor. This switch energizes the main-drive motor, time-delay relay, motor-control panel and the heat-sink blower. The time-delay relay provides a 3-second delay for the motor, after the main drive switch has been turned on. This 3-second delay is to allow the motor time to build up speed before the application of the transport mechanism load.

2. An auxiliary main drive switch is located on the dryer control panel. This switch permits an operator in the lighted room area to control the main-drive motor.

3. The dryer fan switch energizes the motor starter relay, where overload protection is contained, and the fan motor starter, thereby energizing the fan motor. The switch then energizes the dryer-heater contactor relay.

As long as heat is required by the dryer (dependent upon the temperature setting) the heaters will be activated by the temperature of the air circulating through the dryer thermostat.

A pilot light located on top of the thermostat control box remains on during the period of time that the thermostat requires heat. A backup (safety) thermostat with a fixed setting of 140° F is in series with the dryer thermostat. This backup thermostat will cause a bell to alarm and the heaters to be shut off whenever the dryer temperature rises over 150° F.

NOTICE: Do not turn off the dryer fan switch until after the temperature of the dryer has decreased from its normal operating temperature of 135 ±5° F to below 110° F.

4. A dryer lamp switch located in the dryer-control section controls the dryer flood lamps located in the dryer section.

Roller Transport System

The roller transport system moves and directs the film's progress through the processor. The roller transport system is composed of 14 roller racks, 15 crossovers, and one multiroll squeegee

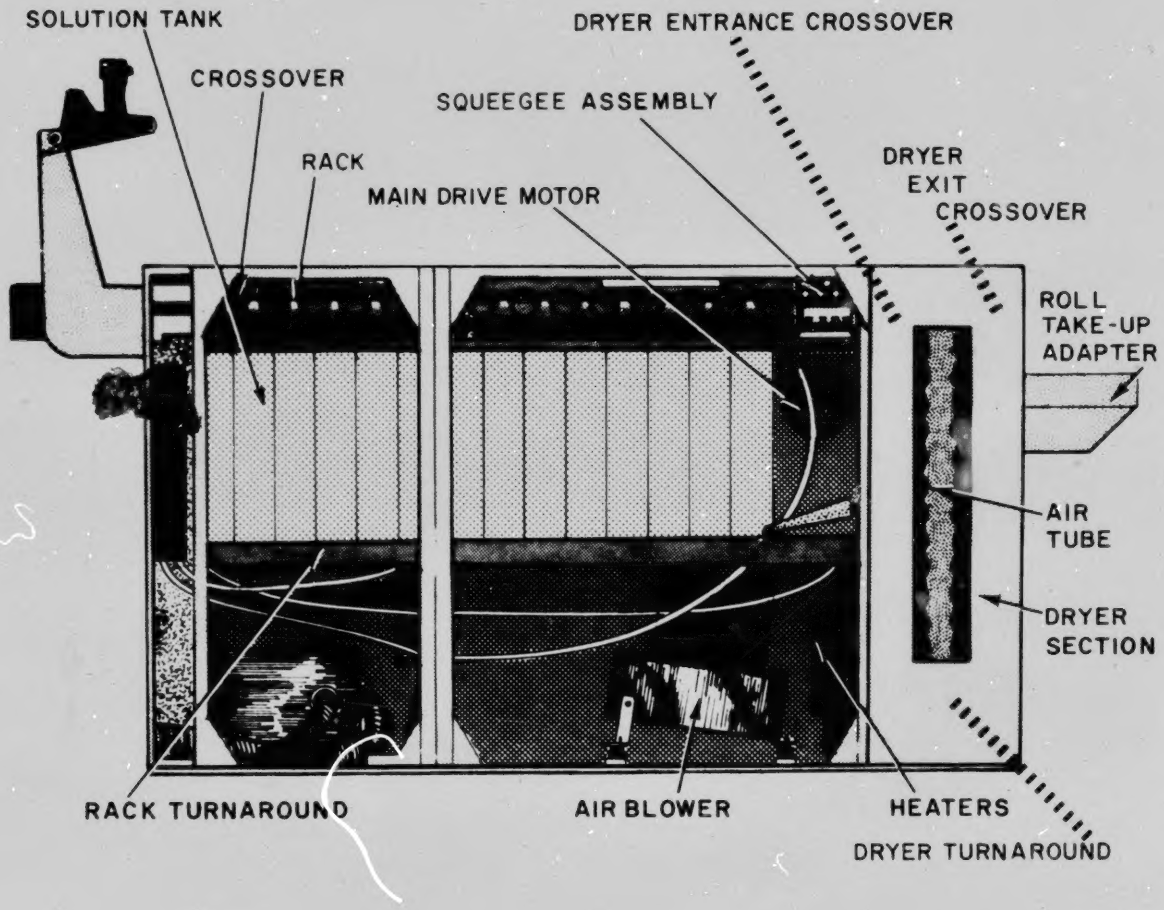

SOLUTION TANK
CROSSOVER
RACK
MAIN DRIVE MOTOR
SQUEEGEE ASSEMBLY
DRYER ENTRANCE CROSSOVER
DRYER EXIT CROSSOVER
ROLL TAKE-UP ADAPTER
AIR TUBE
DRYER SECTION
RACK TURNAROUND
AIR BLOWER
HEATERS
DRYER TURNAROUND
PH.429

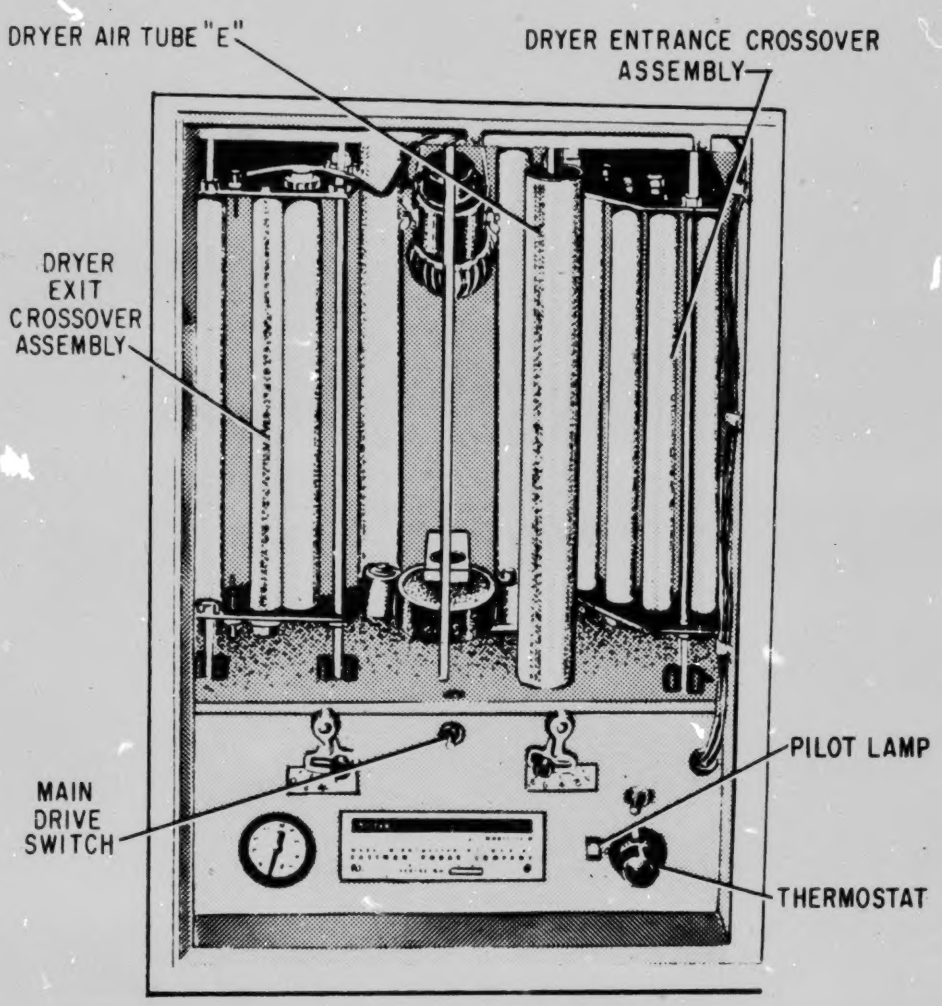
Figure 7-17.—EH-73 processor components.

in the processing section. (See fig. 7-20.) Unopposed chain drive rollers mounted in a staggered path in each roller rack directed the path of the film. The rotation of these rollers conveys the film from roller to roller as the film moves throughout the processor.

A turnaround assembly is located at the bottom of each rack. (See fig. 7-20 and 7-21.)

The turnaround assembly reverses the direction that the film is traveling vertically by 180 degrees. This enables the film to transfer from one set of vertical rollers to another.

A crossover assembly (fig. 7-18) at the entrance conveys the film to the first roller rack. Located between each pair of racks, at the top, are other crossover assemblies which transfer the film from one set of roller racks to another. The last crossover assembly in the processor conveys the film to the multisqueegee assembly. A polyethylene coating is placed on certain of the rack transport rollers to reduce surface deposits on the rollers. The film is squeegeed before being transferred from one solution to the next, by the last roller in each rack and those before the crossovers and the crossover assemblies, to minimize the carryover of excess chemicals and prevent some chemical contamination. The squeegee assembly roller and dryer rollers have their


DRYER AIR TUBE "E"
DRYER ENTRANCE CROSSOVER ASSEMBLY
DRYER EXIT CROSSOVER ASSEMBLY
PILOT LAMP
MAIN DRIVE SWITCH
THERMOSTAT

PH.430

Figure 7-18.—EH-73 dryer section.

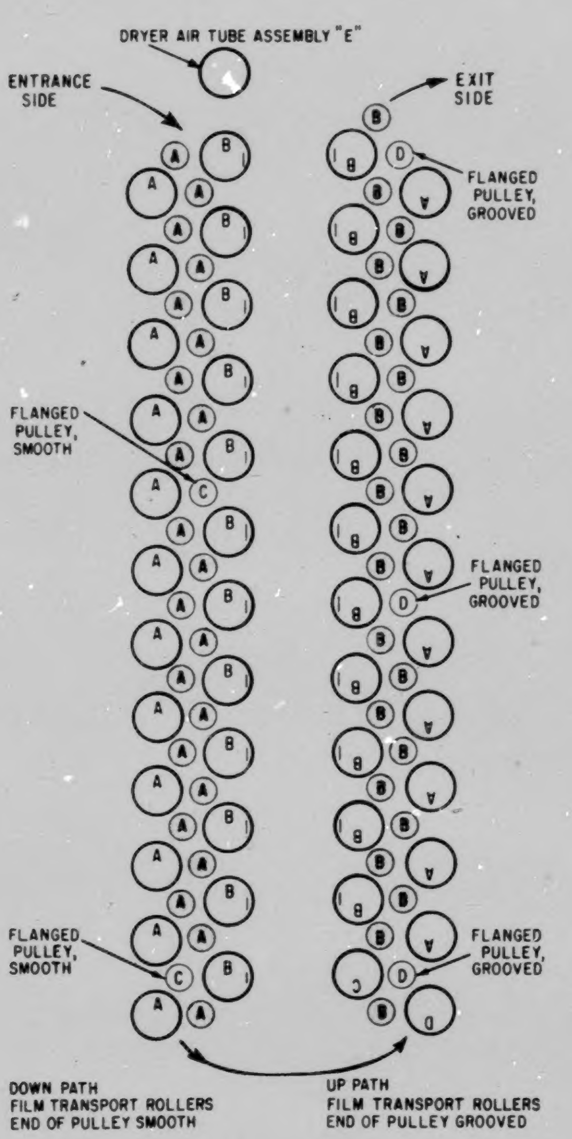
surface speed increased. This prevents slack buildup because of the film stretching.

Dryer Transport System

The dryer transport system consists of an entrance crossover, two vertical rows of unopposed belt drive rollers which are staggered, a turnaround, and a series of air tubes mounted between the transport rollers. The film is directed from one transport roller to the next by guide pins that are mounted on the air tubes.

EH-73 CONTROL CONSOLE

Control of the EH-73 is accomplished by means of a separate control console which is connected to the processor by means of electri-

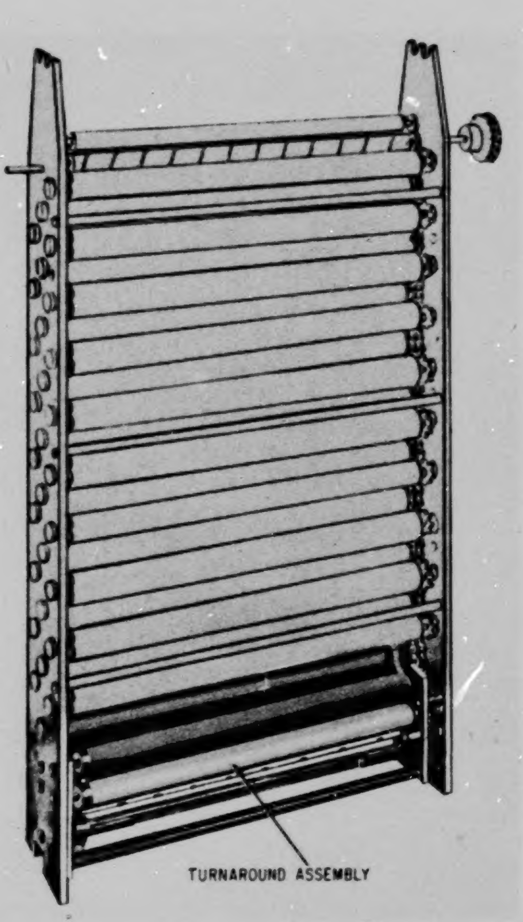

DRYER AIR TUBE ASSEMBLY "E"
ENTRANCE SIDE
EXIT SIDE
FLANGED PULLEY, GROOVED
FLANGED PULLEY, SMOOTH
FLANGED PULLEY, GROOVED
FLANGED PULLEY, SMOOTH
FLANGED PULLEY, GROOVED
A
B
C
D
DOWN PATH
FILM TRANSPORT ROLLERS
END OF PULLEY SMOOTH
UP PATH
FILM TRANSPORT ROLLERS
END OF PULLEY GROOVED

PH.431

Figure 7-19.—Arrangement of dryer air tubes and film transport rollers.

cal wiring and plumbing. Refer to figures 7-16 and 7-22.

Electrical controls for the EH-73, other than those which were placed directly on the processing machine, are located on the control console. Mechanical, chemical, and water control of the EH-73 processor are also accomplished by means of various knobs, indicators, and valves on the control console. The console's various controls and their respective components will be discussed in the following paragraphs.

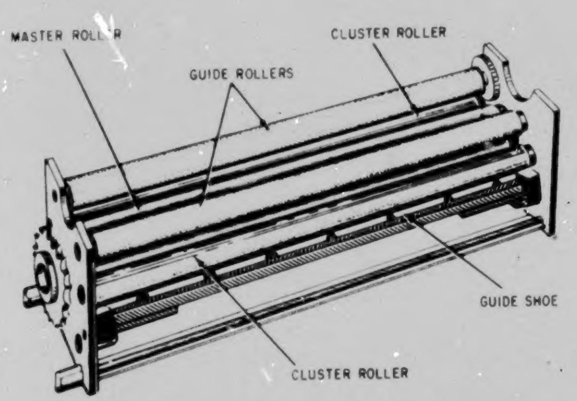

TURNAROUND ASSEMBLY

PH.432

Figure 7-20.—Roller rack assembly.

EH-73 Console Electrical Controls

There is no main power switch furnished with the EH-73. Therefore a safety disconnect switch must be placed in the feed line. This switch should be placed in the white-light area close to the control console. A 100-ampere thermomagnetic circuit breaker should also be mounted in



PH.433

Figure 7-21.—Turnaround assembly.

the lighted room area close to the control console. The safety disconnect switch will be designated hereafter as the main power switch.

The EH-73 processor is designed to operate from a 120/208-volt a-c, 60 Hz power source. The main power switch in the ON position energizes all components up to the switches for the individual control stations.

The master replenisher pump switch energizes the stabilizer metering pump and eight separate replenisher pump switches, which replenish the various processing tanks from the respective storage tanks. The master recirculation pump switch energizes the eight separate recirculation pump switches to circulate the processing chemicals in the following manner.

The neutralizer, first stop bath, bleach, and fixer follow what is referred to as the normal recirculation procedure. Each chemical leaves its respective tank in the EH-73 and passes through its recirculation pump, solution filter, heater, and the thermowell and then returns to its processing tank.

In addition, the prehardener solution goes through a heat exchanger, between the solution filter and solution heater in the recirculation system.

The first developer goes through a heat exchanger and a booster heater, and the color developer goes through a booster heater.

Water for the recirculation heat exchanges, as well as the replenisher heat exchangers is supplied from the wash system.

NOTE: Wash water temperatures vary according to the type of film being processed with a ±5° tolerance. Check Kodak processing specifications for proper temperature settings.

The heat exchangers previously mentioned aid in the control of the prehardener and first developer solution temperatures by overcoming heat buildup through means of tempered water flowing through the outer jacket of the heat exchanger.

Booster Heater Switches

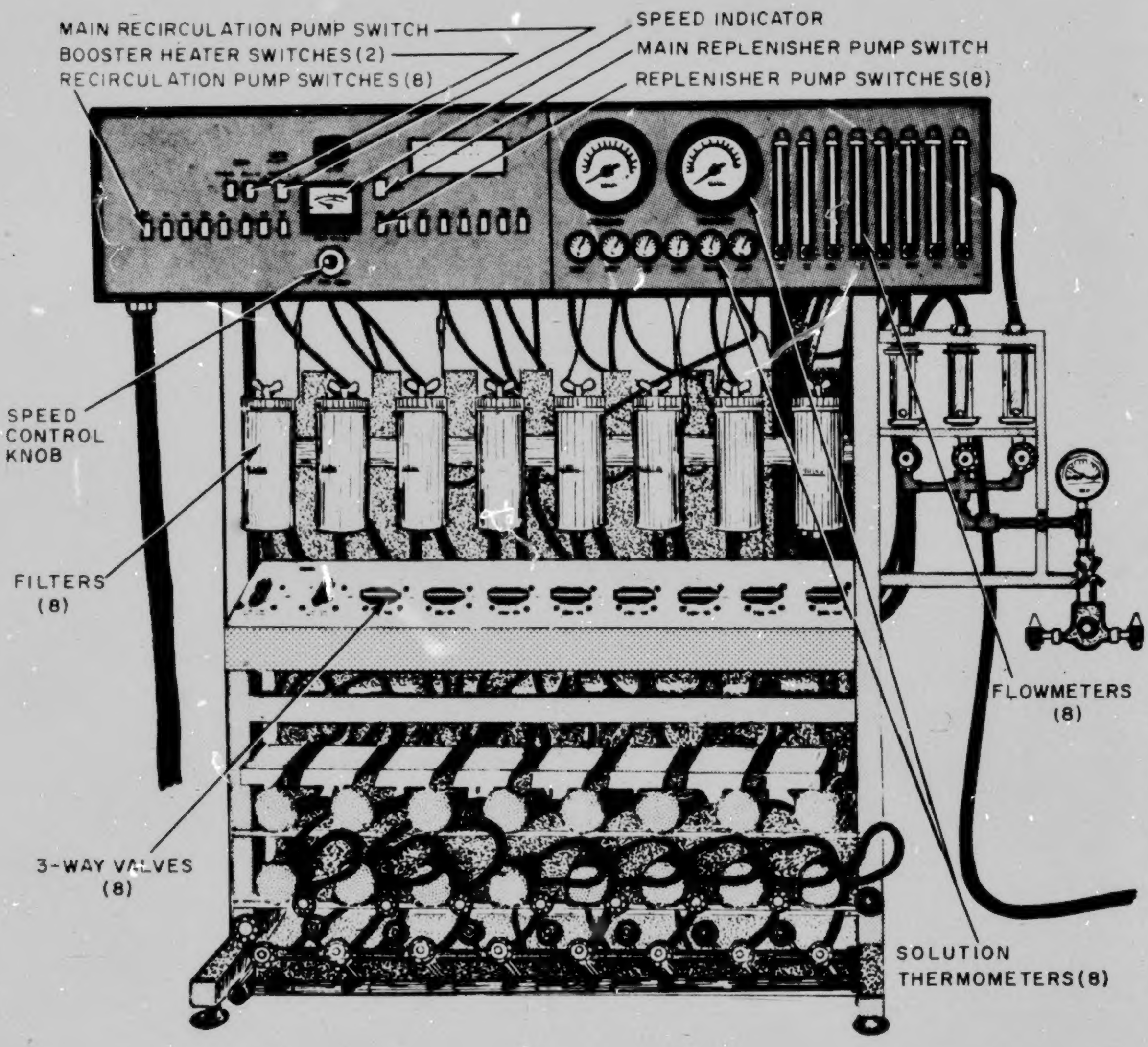
The booster heaters provide additional heating to the first developer and color developer to enable them to quickly reach and maintain selected temperatures. There are two booster heater switches, one each for the first developer and the color developer. This is a three position switch having START, ON, and OFF positions. In the START position the switch will return to the OFF position after it has been momentarily depressed. Once they have been started, the booster heaters will continue to operate until no further heat is required by the solutions thermostat. The booster heater will then be automatically turned off by a relay. In the ON position the booster heaters are controlled by the thermostat and operate automatically whenever the thermostat indicates that heat is required. If the switch is placed in the OFF position the heaters are deenergized and will not work.

Mechanical Control

The speed control knob located on the control console regulates the speed of the film through the processor. The speed of the film through the processor is shown by the speed indicator.

Chemical Solution and Water Controls

These controls contain eight recirculation and eight replenisher pumps of the centrifugal type. These pumps, located within the control console, are magnetically coupled to their individual pump motors.


MAIN RECIRCULATION PUMP SWITCH
BOOSTER HEATER SWITCHES (2)
RECIRCULATION PUMP SWITCHES (8)
SPEED INDICATOR
MAIN REPLENISHER PUMP SWITCH
REPLENISHER PUMP SWITCHES (8)
SPEED CONTROL KNOB
FILTERS (8)
FLOWMETERS (8)
3-WAY VALVES (8)
SOLUTION THERMOMETERS (8)

PH.434

Figure 7-22.—EH-73 control console.

STORAGE TANKS

Eight separate valves located on the control console assist in the regulation of chemical replenishment of the processor from the chemical storage tanks. These control valves have a three way position control. The QUICK-FILL position is used for rapid filling of the processing machine tanks from the chemical storage tanks.

In the QUICK-FILL position the replenisher flowmeter which limits chemical flow is bypassed, allowing the replenisher to be pumped from the replenisher chemical storage tank directly into the processor tank at a rate of 2 gallons per minute.

NOTE: Six of the EA-5 replenishers are identical to their working solutions.

In addition to the valves in the controls for the water and chemistry there are also eight each of the following: solution filters, flowmeters, and solution thermostats, for each of the chemical storage tanks and the machine processing tank combination. Two bypass valves located on the left side of the console, when in the HEAT EXCHANGE position, permit water to pass through the two recirculation heat exchangers and two of the four replenisher heat exchangers before going to the wash tanks. When in the BYPASS position the water does not go through the two recirculation heat exchangers, but it does go through the two replenisher heat exchangers, then to the wash tanks.

EKTACHROME RT SPEEDUP MODIFICATION FOR THE EH-73A PROCESSOR

The processing speed of the EH-73A has been increased from 3.2 ft/min to 5.4 ft/min by Ektachrome RT speedup kits and the use of EA-5 chemistry. At the time of this writing the RT speedup kit is being installed on all EH-73A's being used by the Navy.

EA-5 Chemistry

Nine chemical solutions are required for the EA-5 process. However, only eight different replenisher solutions are required for replenishment, since the first stop bath and second stop bath are identical. A step by step explanation of the various solutions used in the EA-5 process and their purpose and result on the film is as follows:

1. Processing tanks 1 and 2 of the EH-73 processor contain a prehardener solution which reduces the frilling and swelling of the emulsion during processing and minimizes the adherence of foreign matter to the film.
2. Processing tank three contains the neutralizer, which inactivates the hardening agents carried over from the prehardener to prevent them from reacting with the components in the developer.
3. Tanks four and five contain the first developer, which reacts with the exposed silver halides in each layer to change them to a negative silver image.
4. Tank six contains the first stop bath, which reduces any swelling of the emulsion during the remaining steps and ceases the first developer's action on the film.
5. Tank seven is an immersion wash tank which washes the first stop bath from the film.
6. Tanks eight and nine contain the color developer. The color developer reacts with the remaining silver halides that were not converted to a negative silver image to form a positive image and produce color dyes.
7. Tank 10 contains the second stop. The second stop deactivates and bleaches out the developing agent in the color developer.
8. Tank 11 is the second immersion wash tank. Its purpose is to wash the second stop and residual chemicals from the film.
9. Tank 12 contains the bleach solution. The bleach solution dissolves the yellow filter layer and antihalation layer in the film. It also converts all of the negative and positive metallic silver images into silver salts.
10. Tank 13 contains the fixing bath solution. The fixing bath removes the silver salts, formed in the bleach solution, from the film. This leaves in each of the film's layers only the positive dye images. The fixing bath also provides additional hardness to the film before it is dried.
11. Tank 14 is the last tank and contains the final immersion wash with a stabilizer. The fixing bath and other residual chemicals are removed from the film and the dye in the film is stabilized in this tank.
12. Drying is the final step in the processing of the film.

PROCESSING PROCEDURES FOR THE EH-73A PROCESSOR

To install fresh solutions in the processor for startups after cleaning, or for initial startups, proceed as follows:

1. Place the two heat-exchange valves in the BYPASS position, unless cooling is required, and close all the drain valves, with the exception of the wash tank valves.
2. Fill tanks one and two with the prehardener-replenisher solution by placing the three way valve in the QUICK FILL position. Turn on

the replenisher switch until the top level of the solution reaches the weirs. Then turn off the replenisher switch and turn the three way valve to the OFF position.

NOTE: To prevent the recirculation pump from syphoning the chemicals through the replenisher pump, whenever the replenisher switch is in the OFF position its corresponding three way valve must also be in the OFF position.

3. Fill tank number three with the neutralizer-replenisher from the replenisher storage tank in the same manner as the prehardener was put into tanks one and two.

4. The first developer and its replenisher cannot be used interchangeably. Therefore the first developer solution must either be pumped or bucketed into tank number five. During this operation a splash guard must be placed between tanks five and six to prevent any solution from splashing over into tank number six.

Install the rack in tank number four, but not tank five. Add the first developer to tank number five only. When the level of the solution has risen high enough to reach the weirs in both tanks four and five, carefully lower the rack in tank five into position.

5. Fill tank number six with first stop bath replenisher directly from the replenisher storage tanks in the same manner described for filling tanks one and two. Make certain that the three way valve is left in the OFF position whenever the replenisher switch for that tank is turned off.

6. Check over the wash rack in tank number seven for proper operation. Then open the tank drain valve, just enough (approx. 1/2 gal/min) to avoid an excessive overflow of water at the weir. Afterwards set the water flow rate at approximately 2 gallons per minute.

7. The color developer and its replenisher differ, so the initial filling of the processor cannot be accomplished directly from the replenisher storage tanks. Place a splash guard between tanks number nine and ten, remove rack number nine, then pump or bucket the color developer into tank number nine. After both tanks eight and nine have been filled, lower the processing rack in tank number nine slowly into position.

8. Tank number 10 is filled with second stop bath replenisher, directly from the replenisher tanks in the same manner as the prehardener in step number two.

9. Tank number 11 an immersion wash tank is identical to tank number seven, so follow the procedure given in step six.

10. Tank 12 is filled with the bleach replenisher directly from the replenisher tank in the same manner as described in step number two.

11. Tank 13 is filled with fixing bath replenisher directly from the replenisher tank in the same manner as described in step number two.

12. Tank 14, the final immersion wash tank, has stabilizer injection directly from the stabilizer and replenisher containers by means of a metering pump. The metering pump will operate whenever the master replenisher switch is placed in the ON position.

Daily Startup Procedure for the EH-73A

A definite procedure must be carried out whenever the processor is started up and film is processed. This procedure will vary to a degree depending upon how long the processor has been idle. The following steps, with the exception of certain cleaning operations, can also be followed after fresh solutions have been placed in the tanks.

1. Remove and inspect all crossover assemblies then rinse each one completely with warm water. Next lift and inspect the developer racks. Notice whether an amount of gray deposit can be seen, particularly on the interior or emulsion side rollers. If a gray deposit can be seen, place the rack in a suitable sink. Then squirt a warm solution of Kodak Developer System Cleaner onto the roller surfaces. Do not use the system cleaner while the rack is still in the processor. Rinse off the crossovers and racks; do not immerse them.

WARNING: Do not allow system cleaner to get into the eyes, on the skin or on the clothing. The cleaner contains sulfamic acid which causes burns. Flush the skin or eyes with large amounts of fresh water for at least 15 minutes after contact. Obtain medical attention as soon as possible, especially if eyes have come into contact with the developer system cleaner. When necessary, buff the rollers with a soft brush or plastic abrasive cloth. The light gray polyethylene covered rollers must be sponged or if necessary a rough towel or cloth can be used for stubborn deposits. Racks and crossovers must be replaced in their proper location, and never interchanged from one solution to another.

2. Replace racks and crossovers in the processor.

3. Check each tank section to insure that the solution level of each is up to the overflow weir. Add the proper solution replenisher if necessary.

4. Energize the power switch to the processor.

5. Put the heat-exchanger valves in the BYPASS position.

6. See that the replenisher tank shutoff valves are all open. These valves are located next to the replenisher pumps. Turn on the recirculation pumps.

7. Place the booster-heater switches in the STARTUP position. The spring-loaded, booster-heater switches will automatically go the OFF position.

8. Turn the supply on for the wash water and check the temperature of the water. Check the flow indicators to insure that the correct rate of delivery is being obtained by each of the three wash tanks. To prevent an excessive overflow of water at the weirs, open the wash tank drain valves a sufficient amount to allow 1/2 gal/min to drain.

9. Energize the main drive switch.

10. Adjust the speed of the processor to 5.4 feet per minute.

NOTE: The speed indicator dial must be checked for accuracy at least once a month.

WARNING: Keep fingers, clothing, jewelry such as rings, watches, and bracelets, and cleaning materials away from moving gears.

11. To insure a lighttight machine replace all covers, and panels.

NOTE: About 20-30 minutes after turning on the recirculation and booster heater switches the solutions should reach their proper operating temperatures.

12. Turn the dryer on.

13. Next process a control strip as in the following instructions: In the dark attach 10 to 15 feet of preprocessed film or Kodak Black Aero Leader, code 5986, to a leader tab. Feed the tab and leader into the processor. Immediately follow the first tab and leader with another tab which has a control strip attached. Whenever the processor has not been in use for a significant period of time, control strips should be processed proceded by a 10 to 15 foot leader to wet the rollers.

14. Inspect the control strip after it has been processed to determine whether or not any corrective action must be taken.

15. After obtaining acceptable photographic and physical characteristics, attach the film to a leader tab made from 7 mil, 11 x 14 inch Estar base film. It is unnecessary for the film to be 14 inches long. Cutting it off to a length of 12 inches will allow it to fit onto the feed tray without overhanging, reducing the risk of starting it into the machine accidentally.

Except when used to lead a control strip or widths smaller than 70mm the leader tab can be cut down to the same width as the film to be processed. When two rolls of 5 inch film are to be processed simultaneously, they should be spliced in alinement with the outside edges of a leader tab that is a full 11 inches wide, leaving a separation of 1 inch between the two rolls.

There may be some tendency, particularly with acetate-based films, for very fine base scratches to form on the starting and trailing edges of continuous lengths of film that are attached directly to a leader tab. Although these scratches are not objectionable for most purposes, they can easily be avoided in the following manner.

Attach 40 feet of Kodak Black Aero leader, Code 5986, to an Estar base leader tab. Splice the original film to the other end of the black leader and let it follow the leader through the processor. To avoid scratches at the trailing end of the original film, presplice 40 feet of black leader onto this end.

16. Minimum tools required for making proper film to film or film to leader splices are a cutting board mounted on a table next to the feed tray, a common straight edge on either side of the cutting board, and a roll of pressure sensitive tape such as Scotch Brand No. 471 (1 inch black).

17. To make proper film to film or film to leader splices proceed as follows. Press two

pieces about 2 inches long, of pressure sensitive tape across the joint of the butted film or film leader, one piece on the emulsion side and the other on the base side of the film. When applying the pressure tape insure that no space is left between the film joints. The sticky side of the tape can make the machine rollers sticky, if it comes into contact with them.

For film wider than 5 inches place a 2 inch piece of tape across the middle of the joint, on both the base and emulsion side of the film. Holddown clamps are recommended during splicing to prevent any misalinement of the film/leader ends. However if clamps cannot be used an alternate method is to place ends to be spliced together in alinement with one another and base to base. Then, as previously described, press the tape along the edges of the film and on the base and emulsion side of the film.

NOTE: Do not leave splices in the machine solutions for extended periods of time. Deterioration and subsequently tape breakage may be caused in time by some of the solutions.

Films and/or leaders having different widths should not be spliced together. The leader and film widths should be the same.

18. A piece of 7-mil Estar base film is used as a leader tab, whenever the leading end of the film is fed into an unthreaded machine and has to be guided in the proper path. Any processed or unprocessed Kodak black and white film on a thick Estar base can be used for leader tabs. The leader tab, except when used to guide a control strip, should be cut to the same width as the film being processed.

19. Start the processing machine drive.

20. Set a moderate tension on the film tension knobs.

21. Turn on the replenisher pumps and valves, in sequence and at the proper interval of time as the first end of the film enters each solution.

22. Adjust the replenisher rate according to the width of the film being processed.

23. Whenever a short roll of film is being processed or there is a delay between successive rolls, a 75 foot leader should be prespliced to the tailing edge of the film to keep the machine threaded, if the leader tab method of processing is not being used.

24. Turn the replenisher pumps and valves off, in sequence, as the trailing edge of the film enters each solution.

25. The EH-73 processor can be kept on standby, with the solutions recirculating and maintaining the recommended temperatures, for periods up to 8 hours without any important changes in photographic characteristics.

EH-73 Daily Shutdown Procedures

If the processor is not used overnight or for longer periods it must be shut down and not placed in the STANDBY position. The following procedures should be followed when shutting down the EH-73.

1. Allow all film or leader in the processor to run out. Then turn off the drive motor and dryer.

2. Turn off all replenisher pumps, three-way valves, recirculation pumps, the main water supply, and the replenisher tanks shutoff valves.

3. Remove the prehardener racks from the processor. Then wash the rollers with warm water (100-120° F). Allow the racks to drain, in a sink, overnight.

4. Turn off the electrical power to the control console and processor.

5. Insure that the building exhaust vents continue to operate and that the processor covers and side panels are in place.

EH-73 MAINTENANCE

The type and amount of effort needed to maintain the EH-73 depend upon the frequency of use and the environment in which the processor is run. The equipment and process solutions must be kept clean and uncontaminated if the physical quality of the film is to remain acceptable. The machine racks should be cleaned once a week in addition to the cleaning done during the daily start-up procedure. Clean the prehardener racks by squirting glacial acetic acid on the rollers and lightly rubbing them with a plastic abrasive cloth. The Eastman Kodak Company recommends Scotch Brite general purpose pads, No. 447. NOTE: DO NOT USE STEEL WOOL. Using water thoroughly, rinse these racks before returning them to their tanks.

Clean the first developer rack rollers, color developer rack rollers, and fixer rack rollers by squirting a warm solution (100-120° F) of Kodak Developer System Cleaner onto these parts. Never immerse the parts in the system cleaner. After applying the cleaner to the rollers, to produce a clean rack, rub them lightly with a plastic abrasive cloth. Before the racks are returned to the processing tanks the cleaner must be thoroughly rinsed from them.

On a monthly basis and more often if needed, glacial acetic acid should be squirted on the walls of the prehardener replenisher tank. The walls of the first developer, color developer, and fixer replenisher tanks should be squirted with a warm solution of Kodak Developer System Cleaner, for cleaning purposes. Before these tanks are refilled with photographic solutions, the cleaning solutions must be thoroughly rinsed from the tanks.

No special cleaners and/or periodic cleaning is necessary for the neutralizer, first stop, second stop, bleach, and wash tanks as they will remain relatively clean. A periodic dumping of the photographic solutions and then flushing the tanks with hot water will prevent foreign material from accumulating on the bottom of the tanks.

If a blue colored deposit forms on the bleach or fixer parts it can be removed by squirting a 10 percent solution of sodium hydroxide on its surface and then thoroughly rinsing with water.

An algae growth is promoted by the soft water in certain areas. In these locations the wash tanks should be drained and cleaned daily.

The following procedure should be followed when cleaning the replenisher and recirculation system:

1. Drain all of the photographic solutions from the machine tanks and replenisher holding tanks.
2. Clean the screen and return it to the strainer holder.
3. Fill the replenisher holding tanks one-half full of hot water. Then using a toilet brush scrub the sides and bottom of the tanks. NOTE: DO NOT USE STEEL WOOL. Additionally, it is recommended that whenever either the replenisher or recirculation system has been contaminated with oil or other foreign matter, a 1 percent solution (by weight) of trisodium phosphate or a solution of 1 quart of trisodium phosphate to 15 gallons of water is recommended for use as a cleaning solution.
4. Pump several gallons of this cleaning solution directly into the drain. The remainder is then pumped through the replenisher flowmeter and finally through the machine's quick fill valve.

NOTE: The recirculation system can be cleaned by the same solutions, if it is collected in the processing tanks after being pumped through the replenisher system.

5. Remove the sho-rate tube and clean it with a narrow diameter test tube brush and warm water, while the holding tank is being drained. Then replace the tube.
6. The replenisher tanks are then rinsed with water; if trisodium phosphate has been used, several water rinses will be necessary.
7. Recheck the strainers after thoroughly rinsing and dumping the tanks. The replenisher (holding) tanks are then ready for refilling with the proper replenisher solution.
8. The prehardener holding (replenisher) tank will probably need additional cleaning because of a relatively insoluble material which tends to accumulate on the walls of the tank. The prehardener's hardening ability will not be adversely affected by this deposit. However, this deposit tends to generate dirt and makes it difficult to read the level of the solution in the holding tank. To remove this deposit drain out any solution remaining in the tank. Then squirt glacial acetic acid on the sides of the tank. The tank can then be readily cleaned by scrubbing with a brush or plastic abrasive cloth. Rinse the tank thoroughly with water after it has been cleaned, and dispose of the solution.

Recirculation System Maintenance

1. Remove the filter holder cap, remove the filter from its holder, then replace the filter holder cap.
2. Fill the tank with water. If the system has been contaminated, add a 1 percent solution of trisodium phosphate to the water.
3. Turn on the recirculation pump and allow the solution in each particular tank to be heated to its normal processing temperature.
4. Add water to overflow the foreign material that collects on the surface of the solutions;

continue this adding of water until very little foreign matter is noted on the surface of the solution. This will generally take about 1/2 hour.

5. Shut off the recirculation pump and drain the tank.

6. Rinse both the racks and tanks thoroughly with water and drain before refilling with the proper photographic solution.

CHAPTER 8

AERIAL CAMERAS

Aerial photography from today's high speed photographic aircraft would have been considered virtually impossible a few years ago. However, as the aircraft was refined, so was aerial photography.

During World War II and the Korean National Emergency, skilled aerial photographers brought back photographic records of hostile coastlines, fortifications, gun emplacements, airfields, troop movements, and camouflaged areas. These photographs provided invaluable information to the Navy's photographic interpreters, and helped immeasurably in winning the war.

In peacetime, aerial photography is used in photomapping to provide accurate up-to-date maps and charts. Other peacetime uses of aerial photography include flood control, control of erosion, forest fire prevention, highway survey, ship gunnery exercises, and photographic identification of all military installations.

A reconnaissance mission is flown to obtain information on enemy installations, troop and equipment movements, bombing targets, and bomb damage. To perform these functions under any given set of conditions, a variety of cameras is required. For example, various focal length lenses and various size formats are required to produce the coverage and scale required for the mission. Cameras must be available for night and day photography under varying conditions of light intensities, altitudes, and groundspeeds.

Most reconnaissance cameras are identified either by the older "K" (Air Force) or "F" (Navy) series designations, such as K-17, K-37, K-38, F-56, etc., or by a later Navy CA series, such as CA-3, CA-13, CA-17a, etc.

A still later system of joint military type designators has been developed to provide identification for various equipment items and products procured under military or Federal specifications, which eliminates the need for any reference to manufacturers' trade names.

This system of assigning type designators for photographic equipment is contained in Military Standard, MIL-STD-155A. At the time MIL-STD-155A was adopted by the Services, it was interpreted as applying to all equipment procured after that date, but not requiring the redesignation of equipment then in service under the various service designators.

For the purpose of identification by the new equipment type designation system, photographic equipment is divided into three general categories. Each category is assigned a distinctive letter designation to indicate a major item, accessory, attachment or component, and a mission letter to indicate the mission or function of each item. Each two-letter combination is provided with a model number assigned in numerical sequence and, when required, with a suffix letter assigned in alphabetical sequence to indicate various changes to the basic model.

The three categories of photographic equipments are as follows:

1. Picture-Taking Equipment (cameras).
2. Picture-Processing Equipment.
3. Picture-Using Equipment.

All three categories are presented at this time although this chapter is concerned with aerial cameras only. Category and mission letters for each of the three classes are identified as follows:

1. PICTURE-TAKING EQUIPMENT (CAMERAS):

Category Letter:

K—Camera.

L—Accessories, Attachments, or Components for Cameras.

Mission Letter:
- A–Reconnaissance.
- B–Strike Recording.
- C–Aerial Mapping.
- D–Scope Recording.
- E–Still Picture (not otherwise classified).
- F–Motion Picture (not otherwise classified).
- G–Special Purpose (including instrumentation).
- M–Miscellaneous (applying to more than one of the above types; used only with accessory letters).
- S–Set or System.

2. PICTURE-PROCESSING EQUIPMENT:

Category Letter:
- E–Processing Equipment.
- F–Accessories, Attachments, or Components for Processing Equipment.

Mission Letter:
- H–Processing Machines.
- J–Developers.
- K–Washers.
- L–Driers.
- N–Printers (including rectifying printers, motion picture printers, contact printers and projection printers).
- M–Miscellaneous (applying to more than one of the above types; used only with accessory letters).
- S–Set or System.

3. PICTURE-USING EQUIPMENT.

Category Letter:
- A–Using Equipment.
- B–Accessories, Attachments, or Components for Using Equipment.

Mission Letter:
- P–Projectors, Still.
- Q–Projectors, Motion Picture.
- R–Viewing Devices.
- M–Miscellaneous (applying to more than one of the above types; used only with accessory letters).
- S–Set or System.

Examples of complete basic nomenclature are as follows:

Camera, Motion Picture KF-1( ).
Floodlight, Electric LM-1( ).
Camera Set, Still Picture KS-1( ).
Processing Machine, Photographic Film EH-1( ).
Dryer, Photographic Print EL-1( ).
Processing Unit, Photographic Film EJ-1( ).
Safelight, Darkroom, Photographic FM-2( ).
Projector, Motion Picture, Sound AQ-1( ).
Viewer, Still Picture AR-1( )
Projection Set, Motion Picture AS-1( ).
Amplifier, Audio Frequency BQ-1( ).

When the first procurement of a production item is made, the parentheses are deleted and the suffix letter "A" is added. An example of a type designation sequence for motion picture camera follows:

KF-8( )	Basic assignment at concept or in research or development stage.
KF-8A	Initial production assignment.
KF-8A1	Initial production item from different manufacturer or having different maintenance parts.
KF-8B	Design modification not affecting one-way progressive substitutability.

The KA-45A and KA-53A reconnaissance cameras discussed later in this chapter have the latest military type designators.

Reconnaissance cameras were formerly divided into day and night reconnaissance cameras. The day reconnaissance group included cameras having forward image motion compensation and nonimage motion compensation. The night reconnaissance cameras were very similar to the day cameras but differ basically in the lens and control system, since artificial illumination is used. With the introduction of the KA-40 and KA-50 series reconnaissance cameras, and the newly modified day/night KA-47A camera, full day or night utilization is available without installation changes.

Cartographic (mapping) cameras are identified either by the older "T" series designation such as T-11, or by a later Navy CA series, such as the CA-8, CA-14.

The cartographic mapping camera is a high-precision camera used for obtaining aerial photography from which photogrammetric measurements can be obtained for making maps and charts. These cameras have a short focal length and wide angular coverage lens of high quality.

They usually record a quantity of information such as time, altitude, exposure number, etc., on each negative.

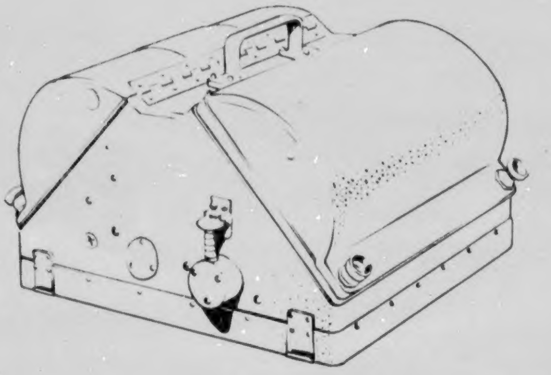
CA-14 PRECISION CARTOGRAPHIC MAPPING CAMERA

The CA-14 Aircraft Mapping Camera shown in figure 8-1 is used to take precise aerial photographs (for preparation of topographic maps) with pertinent data recorded on each exposure. The camera has a calibrated 6-inch f/6.3 lens (which utilizes Waterhouse stops). It has shutter speeds of 1/10 to 1/500 second. The complete camera unit consists of camera body and magazine. It may be used in standard camera mounts.

DETAILED DESCRIPTION

Camera Magazine

The CA-14 camera magazine (fig. 8-2), which may be used interchangeably on any CA-14 camera body without affecting camera calibration, accommodates a 9 1/2-inch film roll 390 feet in length. This length is sufficient for approximately 450 to 460 exposures. The magazine has a vacuum indicator light and an automatic shutoff mechanism for film runout.



PH.436

Figure 8-2.—CA-14 camera magazine.

Camera Body

The camera body (fig. 8-3) is composed of two separate units–the camera body, and the inner cone assembly. (See fig. 8-4.) The camera body houses the case drive, the case drive motor, the magazine locking latches, and various electrical components and wiring for the proper operation of the camera.

The inner cone assembly, which is mounted within the interior of a CA-14 camera body, includes a focal plane frame, an inner cone casting, a 6-inch metrogon lens and routing provisions for an intralens shutter and shutter speed transmission assembly.

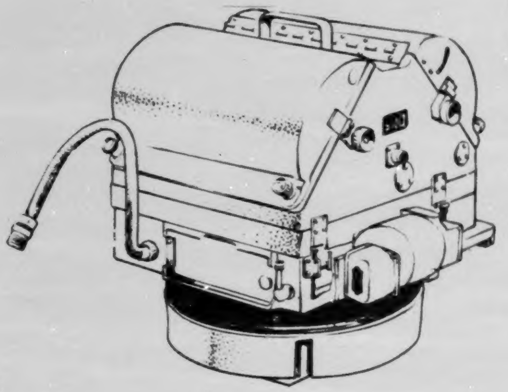


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Figure 8-1.—CA-14 Aircraft Mapping Camera.

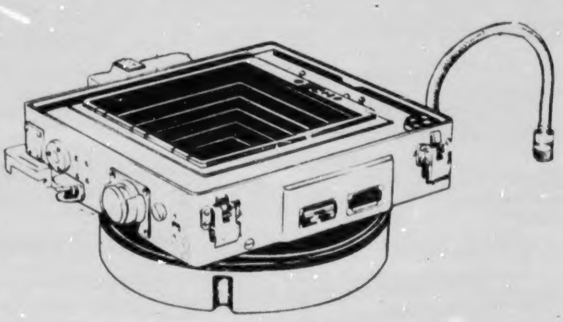

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Figure 8-3.—CA-14 camera body.

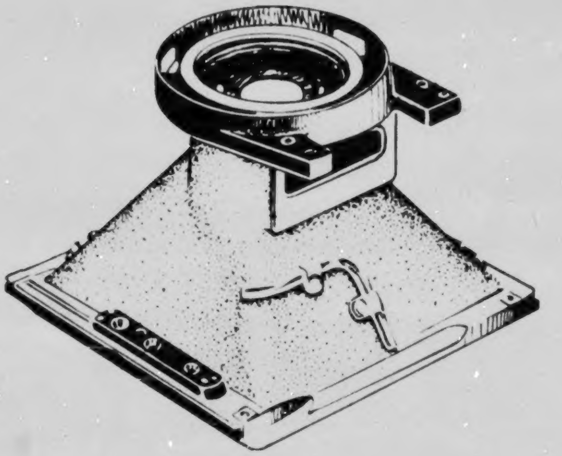

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Figure 8-4.—Inner cone assembly.

1. FOCAL PLANE FRAME. The focal plane frame, which is a precision-machined surface at the top of the inner cone casting, provides a rigid and a fixed relationship between the metrogon lens and the focal plane. The focal plane frame consists of fiducial markers, calibrated focal length markers, engraved silhouettes both for lens serial number and calibrated focal length, and apertures for data recording lenses. Inner edges of the focal plane frame form a 9 x 9 inch perimeter for a picture area on each film negative. Lens serial number and calibrated focal length silhouettes, illuminated by reflected light from data-recording lamps, are registered on the outside periphery of this picture area, making a total negative area of 9 x 10 1/4 inches.

2. INNER CONE CASTING. The inner cone casting is fabricated as a one-piece unit which incorporates light baffles from the focal plane frame to the rear metrogon lens mount. These baffles are provided for light diffusion when the camera is in use.

3. SIX-INCH METROGON LENS. This lens is a calibrated 6-inch f/6.3 class T optical unit which is composed of two basic elements fixed at an infinity focus. A smaller element located on one side of a Rapidyne shutter consists of two lenses secured in a rear mount and held in position by two retaining rings. A larger element, located on the opposite side of the Rapidyne shutter consists of two lenses mounted in like manner. A filter, secured in its own mount, is provided within the front mount of the larger element. Both lens elements are so oriented to one another that maximum performance of this optical unit is obtained. This critical position is indicated by two red dots, one on each side of the two lens mounts, which must be diametrically alined with corresponding red dots on the inner cone casting. A purple dot and yellow dot are included in the front mount. The purple dot indicates that lenses are antireflection coated, while the yellow dot indicates that optics will meet certain temperature requirements.

Front and rear lens mounts are provided with locating holes which engage dowel pins located in the inner cone casting. Front and rear lens mounts are secured on this casting with four screws. Since location of this hole is different on front and rear mounts, a metrogon lens once mounted in a specific casting cannot be interchanged. This assembly method is followed for maintenance of maximum optical performance from each CA-14 camera.

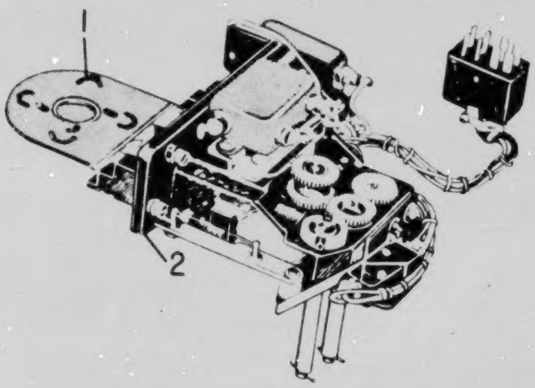
4. INTRALENS SHUTTER. An intralens shutter on a CA-14 camera features a drawer type design for easy insertion and removal from an inner cone assembly mounted on a camera body. This intralens shutter consists of an adapter housing mechanism (2 of fig. 8-5) and a Type B-2 Rapidyne shutter (1 of fig. 8-5). As the Rapidyne is used in several of the modern type aerial cameras, it will be fully discussed in a later section of this chapter.

PERFORMANCE CHARACTERISTICS

The CA-14 mapping camera, designed for electric operation, is capable of a 3-second recycle rate.

Functional Description

The electrical impulse from an intervalometer actuates a solenoid which trips the case drive. The Rapidyne shutter, which has been wound and cocked under tension, is tripped in turn by a mechanism in the case drive. When the case drive trips the Rapidyne shutter, an electrical circuit is



PH.439

Figure 8-5.—Intralens shutter, intralens type B-2.

closed immediately to start drive mechanisms which wind and reset the Rapidyne shutter. At the same time the camera magazine transports film across a focal plane by coupling pickup from the case drive. This magazine drive automatically controls film movements such as metering the desired amount for each photography and stopping film transport. It also opens a magazine vacuum valve and depresses the vacuum pressure plate in proper sequence in order to acquire correct film flatness for each exposure. At the end of each camera cycle the case drive mechanism automatically breaks an electrical circuit to stop camera operation until the next impulse is received from the intervalometer.

Data Recording

This camera records legibly on each film exposure the following pertinent data: Lens serial number and calibrated focal length, camera serial number, exposure counter reading, time of exposure, flight altitude, data card notations, and fiducial marks.

OPERATION

Magazine Loading

It is not necessary to remove the camera from the aircraft camera mount in order to detach the magazine for film loading operations.

The CA-14 camera magazine permits an operator to start loading in darkness and to complete film loading in daylight without fogging the film installed in the supply side of the magazine chamber.

Preflight Operation

Place the camera magazine on the camera body and secure it to the body by closure of the magazine locking latches. If the camera has been removed from the aircraft for any reason, install the loaded camera in the aircraft camera mount. Connect all the necessary cables and hoses to the camera. These are:

1. Power and intervalometer cable.
2. Synchronizer cable.
3. Operation indicator cable.
4. Magazine vacuum hose.
5. Altimeter static hose.

Check to make sure that all hoses and cables are free from the gimbals on the aircraft camera mount. Open and latch the takeup side magazine cover. Turn the POWER and INTERVALOMETER switches mounted in the aircraft to the ON position for automatic camera operation, to check for proper engagement of the magazine drive coupling. After insuring that the magazine is taking up properly, secure the takeup side magazine cover, and turn the power and intervalometer switch to the OFF position.

Set the recording chamber instruments as follows: Remove the recording chamber door from the camera body; wind and reset the navigation watch to the hour of the day; zero the camera exposure counter by depression of the associated reset lever; set the altimeter to the altitude above sea level at your particular location; and make required notations on the data card. Replace the recording chamber door.

The last preflight operation to be performed is to set the proper shutter speed (in accordance with anticipated weather conditions over the mapping area and the speed of the film being used).

Flight Operation

On arrival over the mapping area, turn the power and intervalometer switches (mounted in aircraft) to ON position. Check the external operation indicator which is illuminated by an impulse for every cycle of camera operation. Intermittently check the magazine vacuum pressure reading while in flight.

CAUTION: A minimum of 2 inches of mercury of magazine vacuum pressure should be maintained at altitudes at which photographs are taken with a CA-14 camera.

When the mapping runs are completed, turn the power and intervalometer switches to OFF position to stop camera operation.

NOTE: When the film supply is expended during flight, the CA-14 camera operation shuts off automatically.

Repairs

The CA-14 camera is a precision instrument which should be repaired by competent repair personnel only.

For further information on the operation and service of the CA-14 camera, refer to T.O. No. 10-10AC-77.

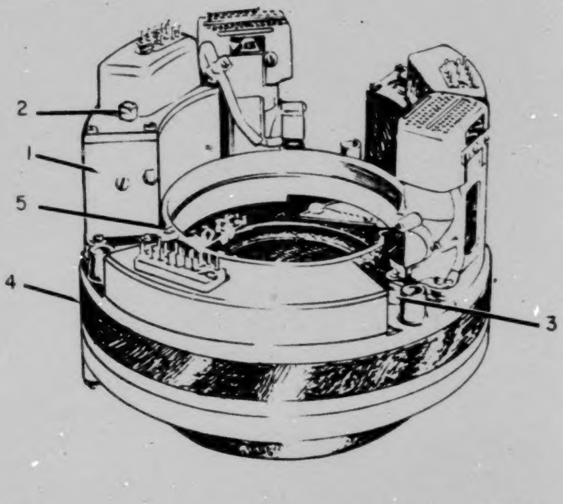
RAPIDYNE SHUTTERS

The Rapidyne shutter (fig. 8-6) is a between-the-lens shutter, characterized by high speed operation, compactness, efficiency, versatility and long life. The B-2 Rapidyne, one of several Rapidyne models, has a valuable feature in the application of a "drawer type" shutter whereby it is inserted between the elements of the lens without separating them, and is easily removed for maintenance and repair. This shutter employs two separate sets of shutter blades driven by separate springs. The first or "A" set trips to open the aperture, and the second set or "B" blades trip to close the aperture at the end of the exposure. Both sets of blades are normally wound by the electric motor and tripped by electrical or mechanical means, depending upon the application of suitable trip pulses. Shutter speeds of Rapidyne shutters range from 1/10 second to 1/700 second.

Shutter Speed

Shutter speeds of Rapidyne shutters are determined by the electromechanical timer unit. Contact "A" in the timer is manually set by the shutter speed dial on the camera body. Turning the shutter speed dial varies the spacing of the "A" and "B" contacts by moving the "A" contact only. This spacing determines the interval between the two trip pulses sent to the shutter. The farther contact "A" is from contact "B," the shorter the interval between trip pulses. The desired exposure time is obtained by setting the shutter speed dial according to the information chart on the camera body, which is as follows:

Shutter Speed	Timer Setting
1/300	V
1/200	W
1/100	X
1/50	Y
1/25	Z



1. Shutter drive assembly.
2. Manual wind nut.
3. Manual trip cap assembly.
4. Shutter housing.
5. Lens locking cam.

Figure 8-6.—Rapidyne shutter assembly.

KB-18A STRIKE CAMERA

The KB-18A is a still 70mm picture camera of the moving film type. (See fig. 8-7.)

Leading particulars of the KB-18A 70mm Strike camera will be found in table 8-1. This camera will be covered in detail in this chapter.

Table 8-1.–KB-18A, Still Picture Camera.

Type	Rotary prism, panoramic, moving film.
Use	Daylight, low level photography, to record weapons effectiveness and aid in damage assessment.
Aircraft	P-3C, A-7E, A-7 A/B, A-6 and F-4.
Camera control system	Lb-17A.
Scan angle	20.5 degrees to either side; 180 degrees fore and aft.
Magazine	LB-16A.
Frame size	9.40 x 2.25 inches.
Recycle time	Autocycle or remote operation 1, 2, or 4 per second.
Prism	Double dove.
Lens	3-inch focal length, f/2.8.
Aperture range	f/2.8 through f/22, continuously variable.
Slit width range	0.02 to 0.20 inches, continuously variable.
Relative shutter speeds	Approximately 1/100 to 1/4000 sec within limits set by cycling rate and AEC.
Aerial exposure index	40, 64, 80, or 200.
Film capacity	250 feet (approx. 300 exposures).

The KB-18A is mounted in the vertical position to take panoramic photographs of the terrain. It will normally provide photographic coverage of 180 degrees along the line of flight (horizon to horizon) and 20.5 degrees to either side of the flight line. The major components of the KB-18A camera system are the camera body, magazine, and control system. The compartment containing the camera is thermostatically controlled to provide an internal operating temperature of 47 degrees F ±20 degrees F. The film ASA rating of either 40, 60, 80, or 200; the overrun time of from 0 to 32 seconds; and speeds of 1, 2, or 4 frames per second must be set during the preflight. Fully loaded, the KB-18A will take approximately 300 exposures. The number of times that the camera can be used will depend upon the frames per second and overrun time set into the camera control.

LB-15A, CAMERA BODY

The LB-15A is the camera body for the KB-18A 70mm still picture camera. It is rigidly mounted within the aircraft with three trunnions. With the camera body are the double-dove prism, lens, heaters, and automatic exposure control (AEC) components. These include the AEC motor feedback potentiometer, variable slit and diaphragm, and the scan drive motor and its associated gear mechanism. The camera body supports the film magazine and provides the linkage gear which couples the drive mechanism to the magazine. Camera operating voltages are supplied from the LB-17A camera control. Protective covers are provided to shield the prism and exposed camera body components from damage and dust.

LB-16A, FILM MAGAZINE

The magazine for the KB-18A camera is a light-tight container with chambers for the supply and take up spools. See figure 8-8.

The film spools are capable of storing 250 feet of film and are constructed of aluminum for proper operation of the camera system. The magazine base contains the film keeper, supply and takeup sprockets, pressure roller and magazine input gear. The magazine heater voltage is supplied from the camera control system. A protective cover is provided to shield the exposed magazine components against damage and dust.

LB-17A, CAMERA CONTROL

The LB-17A camera control for the KB-18A contains all the switches, electronic units, and

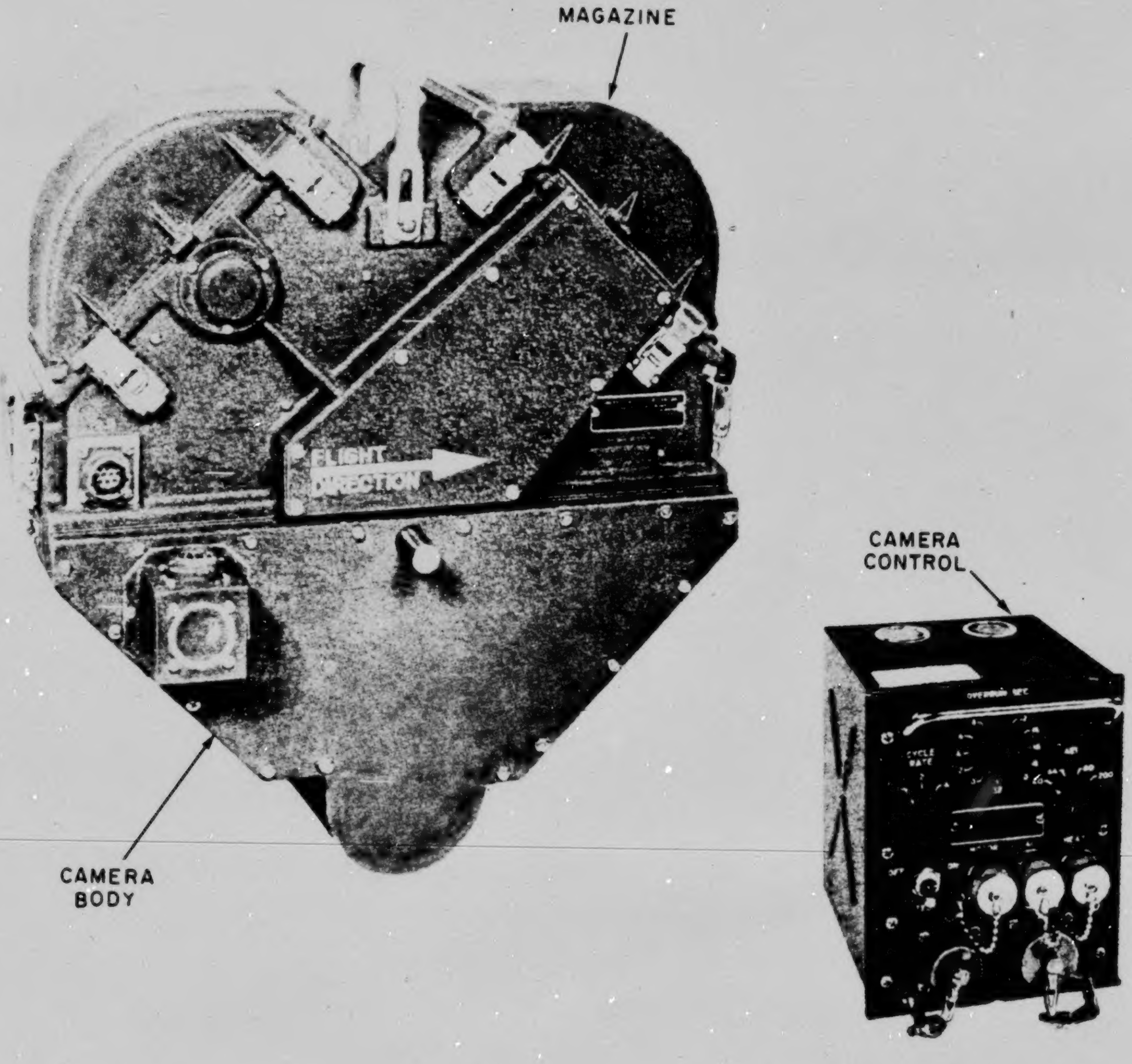


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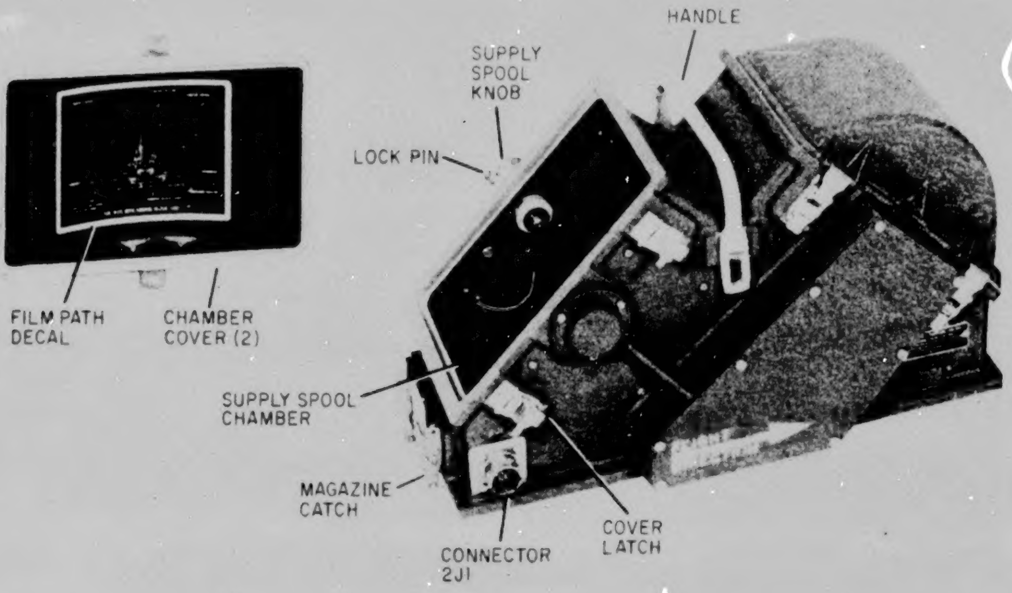
Figure 8-7.—Still picture camera, KB-18A.

connectors necessary for operating the camera system. (See fig. 8-9.)

Power and command voltages are supplied to the control system by the aircraft through connector 3J1, figure 8-9. Camera operating voltage is supplied to the camera body by the control system through connector 3J2. If a manual cockpit control is provided, such as the A311 used aboard the P-3C aircraft, the LB-17A and subsequently the KB-18A camera can be remotely operated from the cockpit.

THE A311, AFT CAMERA CONTROL BOX

The KB-18A will operate automatically upon the release of "kill stores" or it can be operated


HANDLE
SUPPLY SPOOL KNOB
LOCK PIN
FILM PATH DECAL
CHAMBER COVER (2)
SUPPLY SPOOL CHAMBER
MAGAZINE CATCH
CONNECTOR 2J1
COVER LATCH

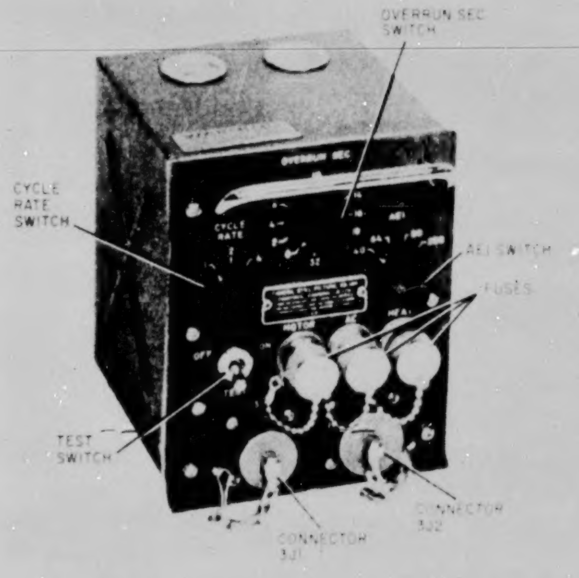
PH.442

Figure 8-8.—LB-16A, film magazine.

manually from the aft camera control box, A311, located in the copilot's station of the P-3C aircraft. (See fig. 8-10.)

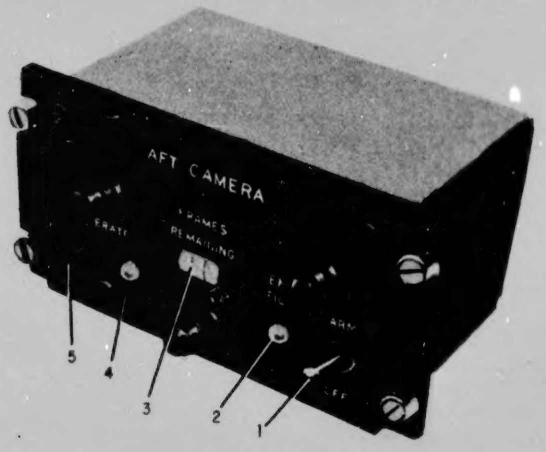
OPERATION OF THE KB-18A

The camera uses a rotating double-dove prism synchronized with the film transport to take 70mm panoramic photographs. Automatic exposure control (AEC) is obtained from a photocell which, with its related circuitry and drive mechanism, controls slit width and diaphragm opening for the correct film exposure. Relative shutter speeds of approximately 1/100 through 1/4000 of a second are automatically controlled as a function of slit width, diaphragm opening, and cycling rate. The prism and film transport mechanism is driven at a preselected rate of either one, two, or four frames per second by the scan drive motor. The unexposed film, guided by a film keeper, travels across the slit at the focal plane. The prism, rotating in front of the camera lens, on an axis which is perpendicular to the direction, exposes the film. The


OVERRUN SEC SWITCH
CYCLE RATE SWITCH
AEI SWITCH
FUSES
TEST SWITCH
CONNECTOR 3J2
CONNECTOR 3J1

PH.443

Figure 8-9.—LB-17A, Camera Control.



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Index No.	Name	Function
1	Arm switch	Controls power to aft camera system.
2	End film indicator	Indicates end of film has been reached.
3	Frames remaining indicator	Indicates number of unexposed frames remaining.
4	Operate indicator	Indicates camera is operating.
5	Operate button	Controls manual operation of camera.

Figure 8-10.—Aft camera control box, A311.

automatic exposure control (AEC) network varies the slit width at the focal plane and/or the diaphragm within the lens, exposing the film according to the brightness of the terrain. The speed of the prism and the speed of the film are synchronized to allow the image being photographed to be progressively registered on the moving film as the prism scans 180 degrees from the front to the rear of the aircraft.

INSTALLATION OF THE KB-18A CAMERA SYSTEM

As indicated previously in table 8-1, the KB-18A camera system is used in several aircraft, including the A-7E and the P-3C. In the A-7E the KB-18A camera is installed in the built in camera station, aft of the main landing mount. Access to the camera station is from the starboard side of the aircraft. Installation on other carrier based aircraft is accomplished by use of the LB-30A or LB-31A camera pods.

Installation of the LB-17A camera control in the LB-30A or LB-31A camera pod is achieved by the following procedure.

WARNING: MAKE CERTAIN THAT ALL ELECTRICAL POWER HAS BEEN REMOVED FROM THE CAMERA POD BEFORE INSTALLING OR REMOVING COMPONENTS.

1. Turn the control box mounting screw counterclockwise until the pressure mount is fully open.
2. Position the control box from the inside of the camera pod until the rear bottom edge of the control box is under the lip at the rear of the pressure mount.
3. Making certain that the bottom of the control box is flush against the pressure mount, turn the mounting screw clockwise until the control box is secured firmly.
4. Remove receptable covers and attach cables.

Installation of the LB-15A Camera Body

The procedure for mounting the camera body in either the LB-30A or LB-31A camera pod is as follows:

1. Remove protective covers from the body, prism, and receptable.
2. Clean the prism, by removing all dust, dirt, and foreign matter using a number 0 camel's hair brush or a gentle flow of moisture free air. Then wipe with lens tissue, avoiding excessive pressure. If smudges remain on the prism, gently wipe with a lens tissue which has been dampened with denatured alcohol (Mil Spec MIL-A-6091). Allow the optical surface to dry and then carefully polish until the blue haze disappears.

CAUTION: Use extreme care when installing the camera body so as not to damage the exposed prism.

3. With the camera door open and the door locking bar in position to support the door, position the camera so that the threaded mounting holes on the camera body are aligned with the holes in the camera mounting bracket.

4. Partially install the three camera mounting bolts.

5. Tighten the three camera mounting bolts until the camera is secured tightly.

6. Attach the cable from connector 1J1 on the camera body to 3J2 on the LB-17A camera control.

Installation of the LB-16A Film Magazine

Install the LB-16A film magazine as shown in figures 8-8 and 8-11, using the following procedure:

1. Remove protective cover from camera body and magazine.

2. Gently lower magazine on camera body insuring that the magazine input gears mesh with camera body linkage gear.

3. Insure that magazine is properly mounted to camera body. If it is not, film breakage and/or damage to components will occur.

4. Engage the four magazine catches with the four camera body catch strikes, and snap catches closed.

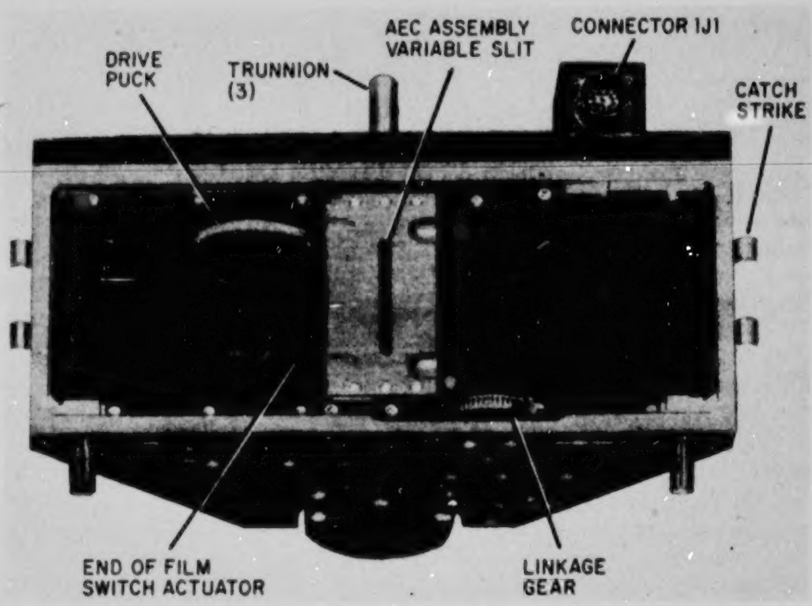

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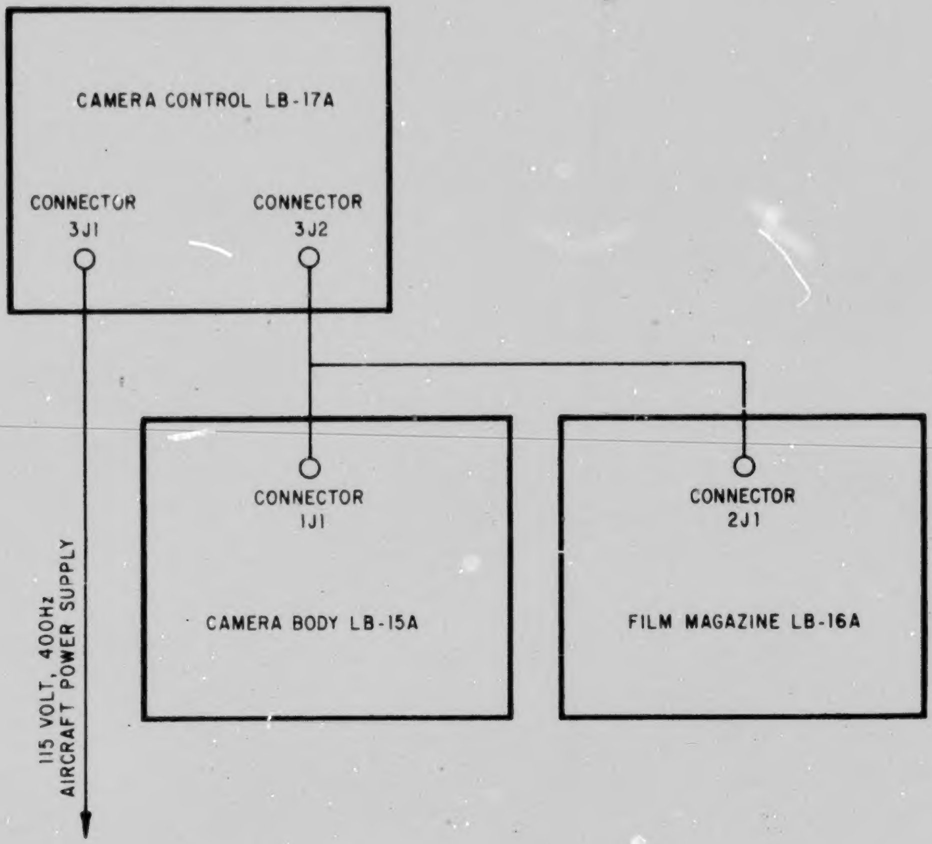
Figure 8-11.—LB-15A, camera body.

5. Attach cable from connector 2J1 on magazine to connector 3J2 on the LB-17A camera control.

Figure 8-12 shows a diagram of the camera interconnecting cables for the KB-18A system.

Camera Loading And Unloading Procedures

Loading procedures are divided into three phases; preliminary procedures, darkroom procedures, and subdued light procedures. The film


CAMERA CONTROL LB-17A
CONNECTOR 3J1
CONNECTOR 3J2
CONNECTOR 1J1
CAMERA BODY LB-15A
CONNECTOR 2J1
FILM MAGAZINE LB-16A
115 VOLT, 400Hz AIRCRAFT POWER SUPPLY

PH.446

Figure 8-12.—KB-18A, camera interconnecting cables diagram.

path through the camera is shown in figure 8-13. This diagram should be referred to before loading the magazine.

PRELIMINARY PROCEDURES.–Refer to figure 8-14 and proceed as follows:

1. Make certain that the surface of the loading area is clean, and free of tools, small parts and other items which may damage the platen area of the magazine or the film.
2. Unlatch the four magazine catches and remove the magazine from the camera body.
3. Rest the magazine with the handle down on a clean flat surface.
4. Loosen film keeper knurled retaining screw and remove film keeper from magazine.
5. Place magazine on its base and remove supply spool cover.
6. Pull supply spool knob out as far as possible.
7. Unlatch the four catches securing the takeup cover and remove cover.
8. Pull takeup spool knob out as far as possible.

Darkroom Threading Procedures

Refer to figure 8-15 as a guide in preparing to thread the magazine in the darkroom.

NOTE: The following procedures must be performed in total darkness.

1. Unpackage roll of film to be loaded.
2. Set magazine on its side with spool knobs facing up.
3. Place supply spool next to magazine supply spool chamber so that film feeds from top of spool and emulsion side faces away from handle. (See fig. 8-15.)
4. Feed leading end of film between supply side idler roller and supply slot until 3 feet of film extends beyond slot. (See fig. 8-16.)
5. Place supply spool in magazine and remove film slack by pulling film extending beyond supply slot. (See fig. 8-17.)

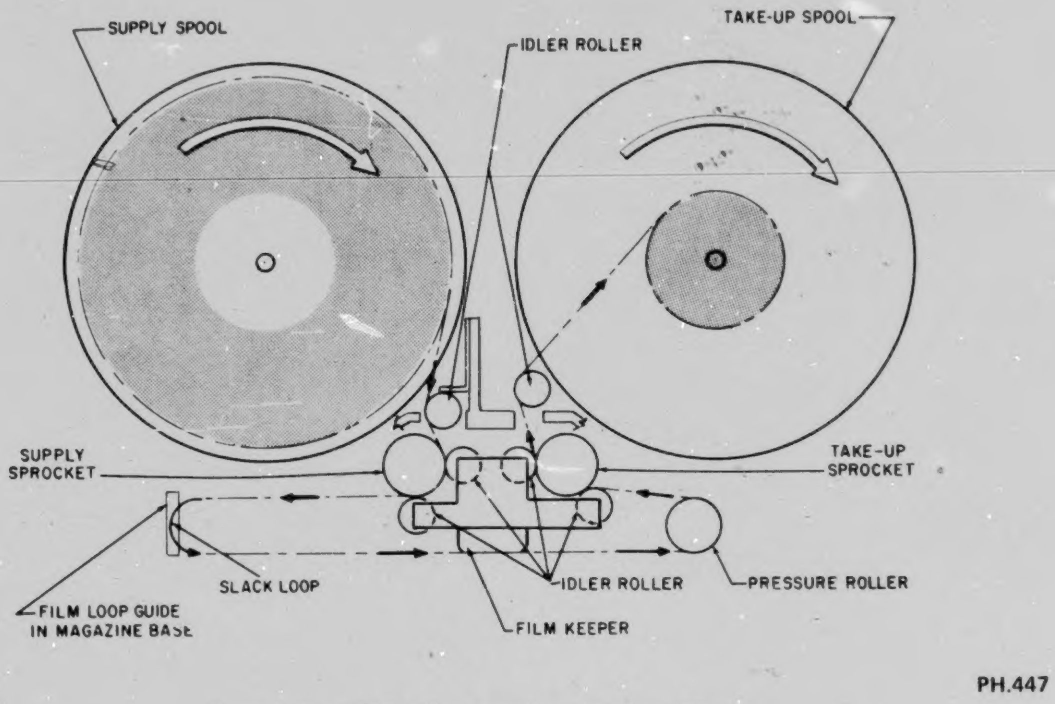


Figure 8-13.–LB-16A film magazine, threading diagram.

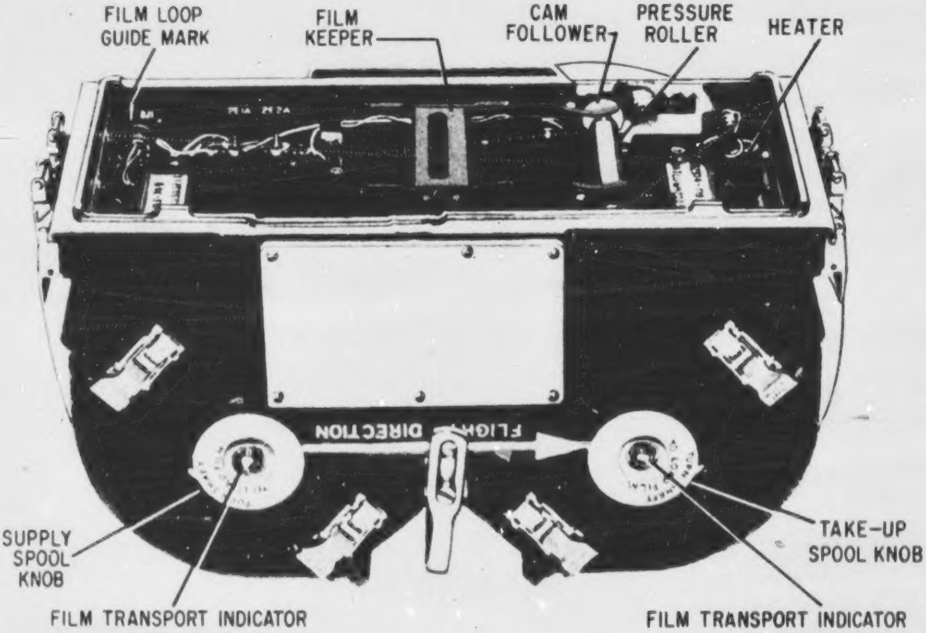

FILM LOOP GUIDE MARK
FILM KEEPER
CAM FOLLOWER
PRESSURE ROLLER
HEATER
FLIGHT DIRECTION
SUPPLY SPOOL KNOB
FILM TRANSPORT INDICATOR
TAKE-UP SPOOL KNOB
FILM TRANSPORT INDICATOR

Figure 8-14.–LB-16A film magazine threading (preliminary procedures). PH.448

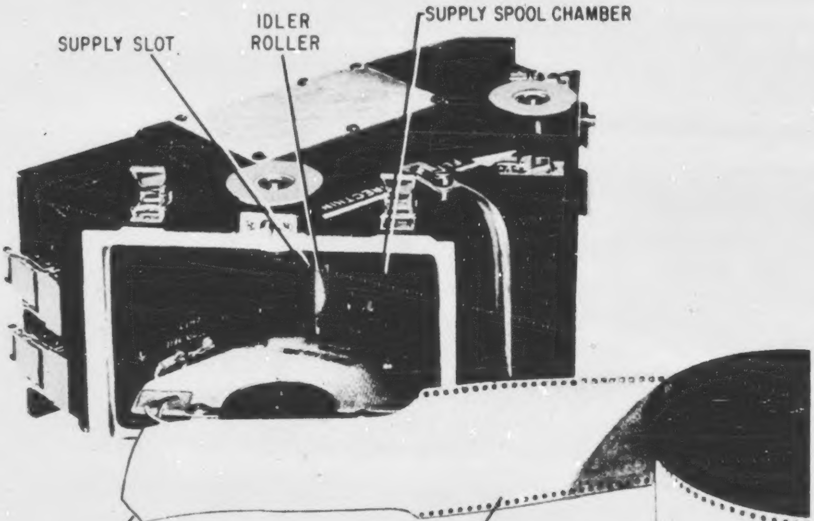
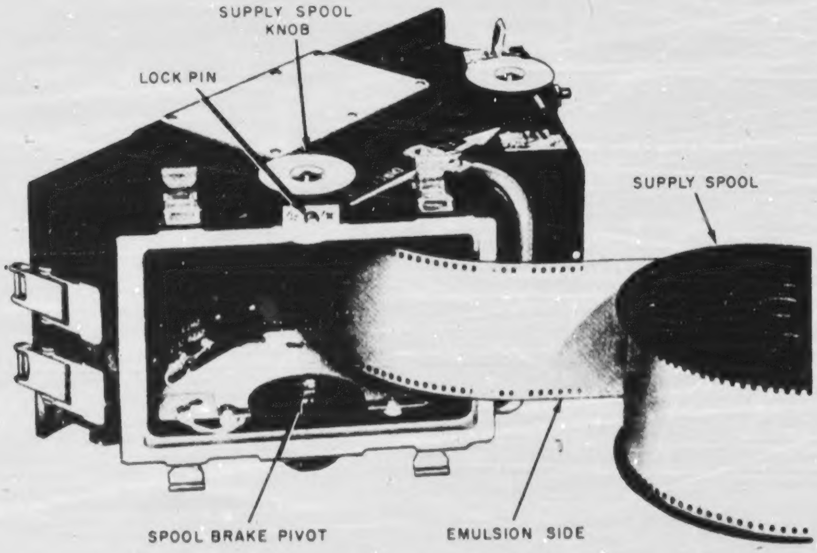
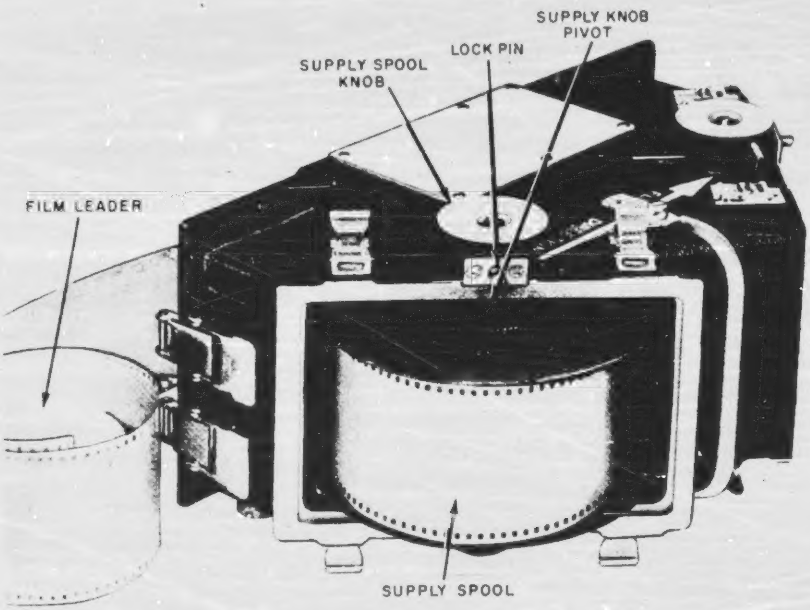

SUPPLY SLOT
IDLER ROLLER
SUPPLY SPOOL CHAMBER
FILM LEADER
EMULSION SIDE

Figure 8-15.–Preparing to thread magazine (darkroom procedures). PH.449


SUPPLY SPOOL KNOB
LOCK PIN
SUPPLY SPOOL
SPOOL BRAKE PIVOT
EMULSION SIDE

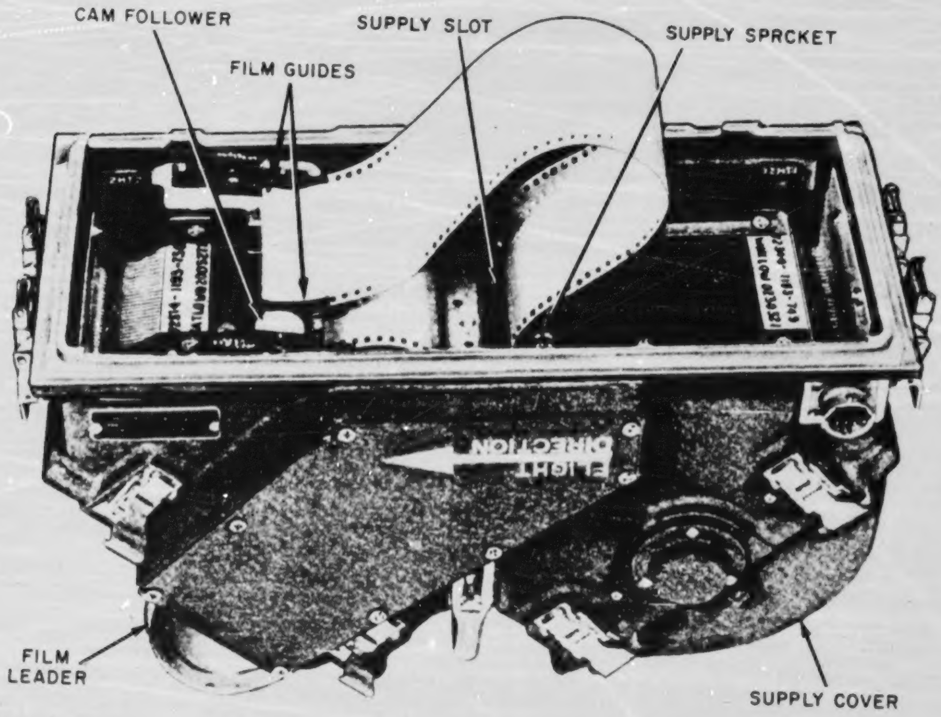
PH.450

Figure 8-16.—Threading supply side of magazine (darkroom procedures).


SUPPLY KNOB PIVOT
LOCK PIN
SUPPLY SPOOL KNOB
FILM LEADER
SUPPLY SPOOL

PH.451

Figure 8-17.—Installing supply spool (darkroom procedures).



PH.452

Figure 8-18.—Routing of film (subdued light procedures).

6. Mount supply spool on spool brake pivot.

NOTE: A screwdriver may be used to rotate slotted film transport indicator until supply knob pivot engages with keyed slot in the supply spool.

7. Engage supply knob pivot with keyed slot in supply spool.

8. Check that the supply spool is mounted properly by depressing the lock pin. If pin cannot be depressed repeat step 7.

CAUTION: Before exposing the film magazine to light, insure that the supply spool is properly mounted in order that the film will not be fogged. If the magazine catches are hard to close it is an indication that the magazine cover is not mounted properly and/or that the lock pin is not fully depressed.

9. Mount the supply cover on the magazine supply side and latch the four catches closed.

SUBDUED LIGHT THREADING PROCEDURES.—Refer to figure 8-18 for film routing procedures to be used in subdued light.

1. Rest magazine on its supply cover and housing.

CAUTION: To prevent damage to the film perforations, do not rub the film against the sprockets.

2. Pull film extending from supply slot until 3 feet of film extends from magazine supply side.

3. Feed film under film guides and over and around pressure roller, then over takeup sprocket and into takeup slot. Insure that the film is properly routed over the idler roller.

4. Pull film leader until film forms a supply loop which extends up to the heater mounting screws; however, insure that the film does not

contact the screws. Check that film is properly routed over the pressure roller. (See fig. 8-19.)

CAUTION: Insure that film keeper index pins are properly alined before continuing with step 5.

5. Rest film keeper in magazine so that the index pins are inserted into locating holes.

6. Check that film perforations are properly engaged with supply sprocket and takeup sprocket teeth. (See figure 8-20.)

CAUTION: Insure that the retaining screw is securely tightened.

7. Tighten knurled retaining screw securing film keeper to magazine base.

8. Insert film edges under film keeper clips.

9. Place film edge over pressure roller and under pressure roller film guides. (See fig. 8-21.)

10. Pull film away from heater mounting screws and toward opposite end of magazine base. Check that the film does not bind on any film guides.

11. Place magazine on its base and check that the film is routed over idler roller in takeup spool chamber. (See fig. 8-22.)

CAUTION: When performing step 12, pull film as fast as possible to insure proper tracking of the film.

12. Holding magazine with one hand and grasping film with the other hand, rapidly pull 18 to 24 inches of film from magazine takeup side. (See fig. 8-22.)

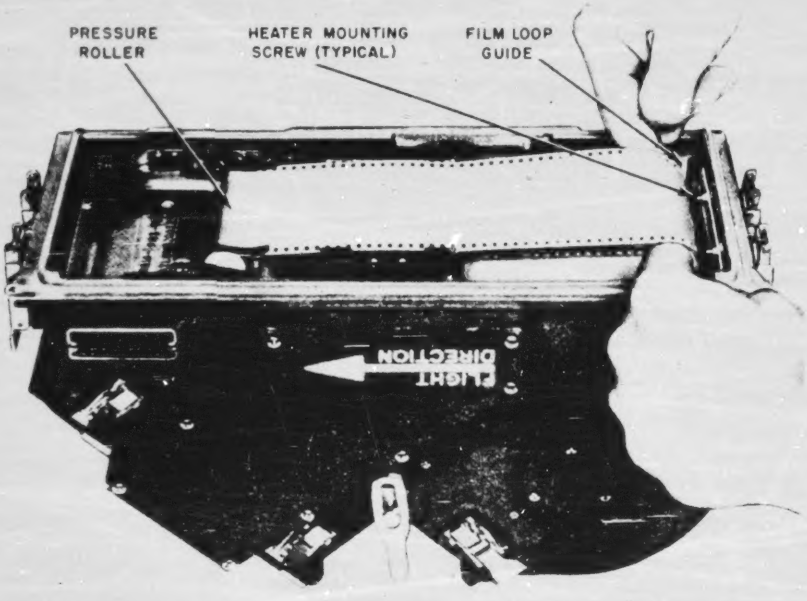
13. Turn magazine over and recheck that proper film loop exists on underside of magazine. (See fig. 8-22.) If it does not, remove film keeper and repeat steps 4 through 12.

CAUTION: Check takeup spool for damage; insure that the flanges are true and not bent. Check that spool hub is clean and free of foreign matter. Do not tape film leader to spool core.

14. Insert film leader into takeup spool slot and wrap two complete turns of film around core. (See fig. 8-23.)

15. Pull takeup spool knob fully out; mount takeup spool. (See fig. 8-24.)

NOTE: A screwdriver may be used to rotate slotted film transport indicator until takeup knob pivot engages with keyed slot in takeup spool.



PH.453

Figure 8-19.—Forming film loop (subdued light procedures).

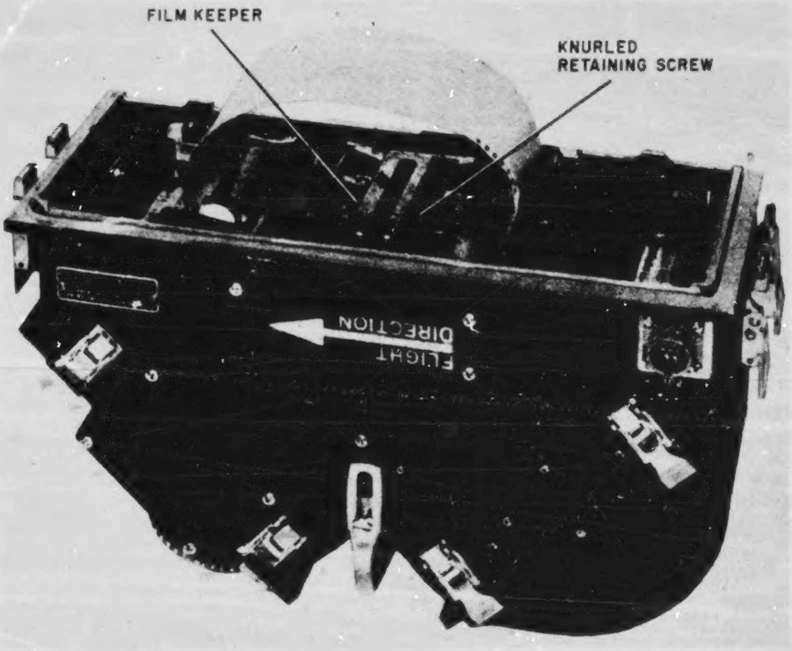


Figure 8-20.—Installation of film keeper (subdued light procedures).

16. Engage takeup knob pivot with takeup spool keyed slot.

17. Check that takeup spool is mounted properly by depressing takeup knob lock pin. If pin cannot be pressed repeat step 16.

18. Rotate takeup spool until film in magazine takeup side is collected.

CAUTION: Insure that the takeup cover is properly mounted. If it is not, film fogging will occur. If catches are hard to close, it is an indication that the cover is not properly mounted and/or that the lock pin is not fully depressed.

19. Mount cover on magazine takeup side and fasten the four catches.

CAUTION: Protective cover must be installed on magazine during storage or transport to prevent fogging of the film.

20. Insure that the magazine is threaded properly, then install the magazine protective cover. (See fig. 8-25.)

21. Mount and latch the magazine to the magazine camera body.

Removing Exposed Film From the LB-16A Film Magazine

To remove exposed film from the magazine proceed as follows:

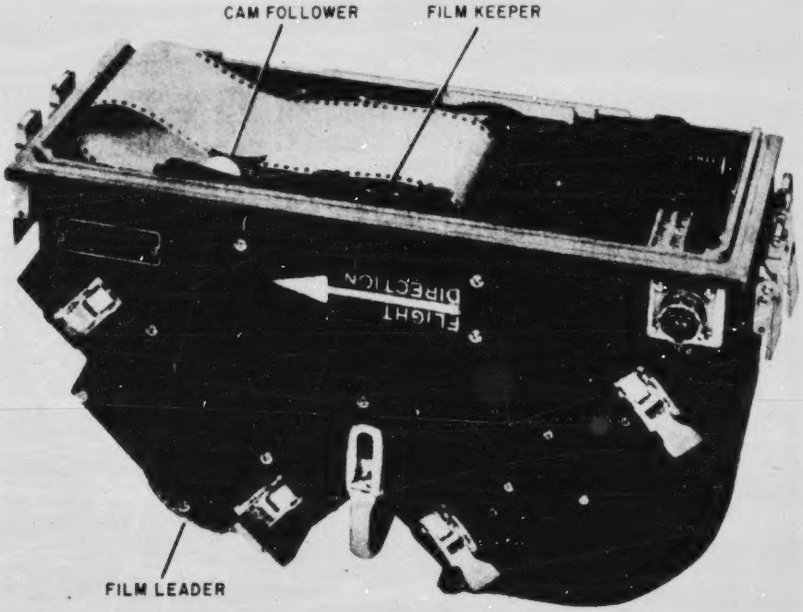
1. Unfasten the four magazine catches and remove the magazine from the camera. Transport the film magazine to the photographic laboratory for processing of the film and reloading the magazine.

2. Cut the film at the supply loop.

CAUTION: The following procedures must be accomplished in total darkness to prevent fogging of the film.

3. Remove the takeup cover by unfastening the four catches.

4. Rotate takeup spool until film is completely wound on the spool.



PH.455

Figure 8-21.—Checking for film bind (subdued light procedures).

5. Pull takeup knob out as far as it will go.
6. Remove takeup spool from magazine and place in a lighttight container.
7. The lights may now be turned on.

KB-18A MAINTENANCE

Maintenance of the KB-18A is accomplished at three levels: Organizational, Intermediate, and Depot.

Organizational Maintenance

The KB-18A system is composed of three components, the camera body, magazine, and control system. Organizational maintenance is limited to the testing of these components with a type LS-83A Test Set Camera System, and the replacement of these overall components using common tools. (Refer to fig. 8-26.)

The LS-83A test set indicates only the defective or malfunctioning component(s). Applicable tests to determine defective parts within the component(s) are accomplished at the Intermediate maintenance level.

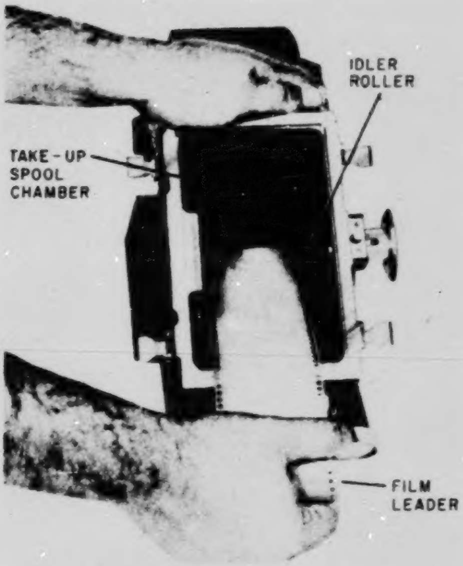
Intermediate Maintenance

The replacement of parts and assemblies using common tools, visual and detailed inspections, testing, troubleshooting, repairing with certain exceptions, cleaning, painting, and lubricating of the KB-18A are done at the Intermediate level of maintenance. Repairs or overhaul which require special tools and equipment based on the conditions described in the following paragraph necessitate the defective unit being forwarded to the depot level for maintenance.

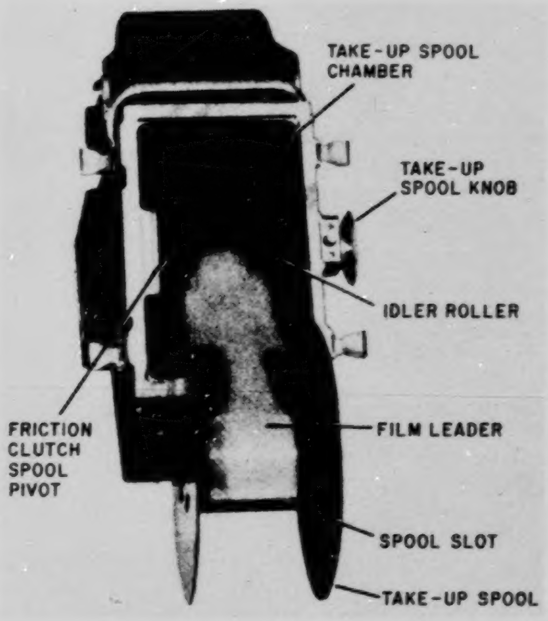
Depot Level Maintenance

Components of the KB-18A system are not turned into the depot solely on the basis of completion of a specified time or cycles of operation. Cameras and major components are forwarded to a depot for overhaul and repair on the basis of individual condition.

Conditions warranting complete overhaul or repair at the Depot level include the following:


IDLER ROLLER
TAKE-UP SPOOL CHAMBER
FILM LEADER

PH.456
Figure 8-22.—Checking film loop (subdued light procedures).


TAKE-UP SPOOL CHAMBER
TAKE-UP SPOOL KNOB
IDLER ROLLER
FRICTION CLUTCH SPOOL PIVOT
FILM LEADER
SPOOL SLOT
TAKE-UP SPOOL

PH.457
Figure 8-23.—Preparing to wind film on takeup spool (subdued light procedures).

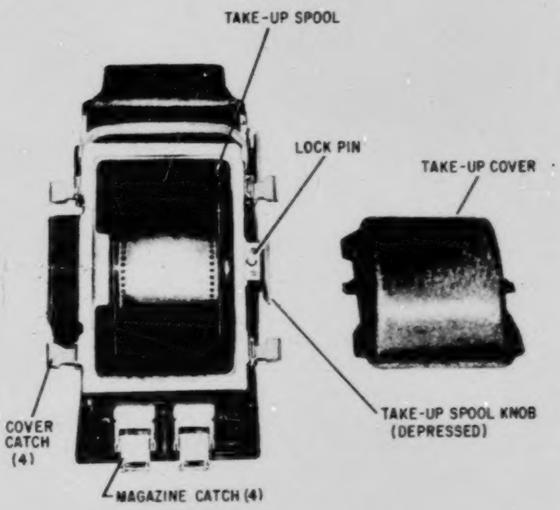
1. Repeated troubles.
2. Erratic troubles.
3. Presence of corrosion, fungus, or metal filings in encasement.
4. Looseness of lens elements.
5. Reports or knowledge of lens out-of-focus.
6. Damage to mating surfaces beyond capability of local activity to repair.

Complete information regarding the operation, testing, troubleshooting, and maintenance of the KB-18A photo system can be found in the Service Instruction Manual, NAVAIR 10-10 AC-116, Still Picture Camera KB-18A.

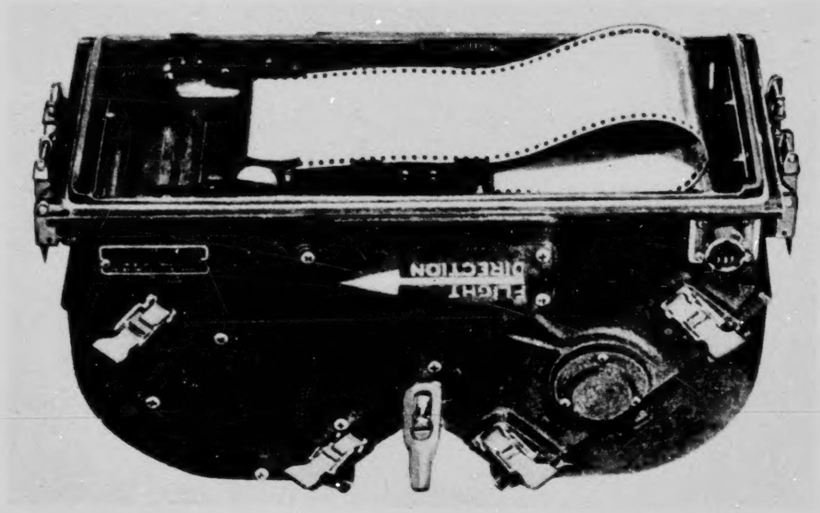
Installation of the KB-18A Camera in the P-3C Aircraft

Refer to figures 8-27A and B. To install the KB-18A in the P-3C the following procedure can be used:

1. Place camera up through mount.
2. Install mount caps on camera trunnion and install bolts.


TAKE-UP SPOOL
LOCK PIN
TAKE-UP COVER
TAKE-UP SPOOL KNOB (DEPRESSED)
COVER CATCH (4)
MAGAZINE CATCH (4)

PH.458
Figure 8-24.—Installing takeup spool (subdued light).



PH.459

Figure 8.-25.—Magazine threaded for operation (normal light).

3. Connect electrical connectors to plugs 1J1 and 2J1 (fig. 8-28).
4. Swing mount and camera installation up into fuselage.
5. Engage spring-loaded pin assembly.
6. Close aft camera door and fasten turn lock fasteners.

Removal of the KB-18A Camera From the P-3C Aircraft

Refer to figure 8-28. The following procedure is used for removal of the KB-18A camera from the P-3C.

1. Verify that the following circuit breakers, on the left forward circuit breaker panel, are open: Aft camera arm sig, aft camera PWR, and REL.
2. Release turn lock fasteners on aft camera door and allow door to swing open.
3. Release spring-loaded pin assembly on mount and allow mount to swing down.
4. Disconnect electrical connectors from 1J1 and 2J1.
5. Remove mount bolts and remove camera.

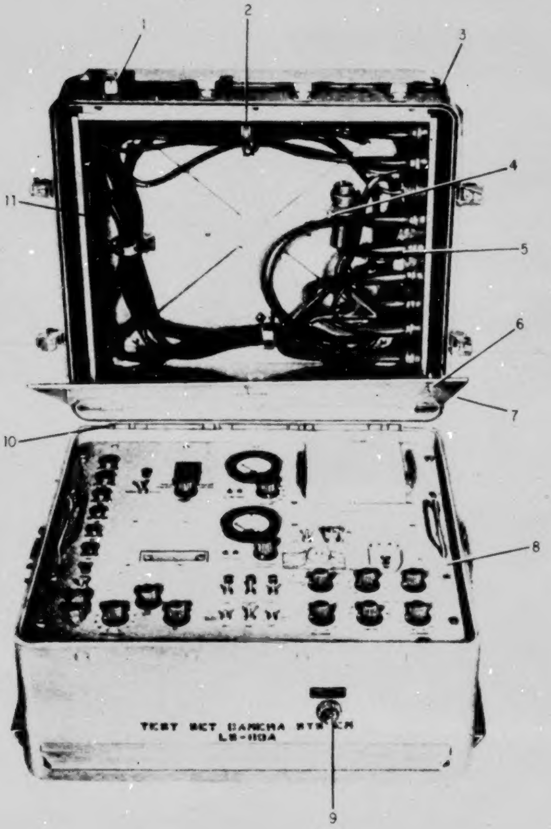
NOTE: The aft camera control A311 is standard panel-mounted, and is removed by releasing the turn lock fasteners. Electrical connectors are of the quick-disconnect type and are rotated 90 degrees to disconnect. Perform an operational check after a camera control unit has been replaced.

KA-40 FAMILY OF CAMERAS

The KA-40 family of cameras consists of the KA-40A, the KA-45A, and the KA-46A series cameras. Because of the similarity of the three type cameras, only the KA-45A will be covered in detail. However, pertinent data are included on the KA-40A, KA-45A, and the KA-46A in table 8-2 for comparison and identification.

KA-45A RECONNAISSANCE CAMERA

The KA-45A camera is a compact, aerial reconnaissance type camera capable of taking exposures during day or night. Forward image motion compensation (IMC) is provided to allow operation within a wide range of aircraft altitudes and groundspeeds. It may be mounted for either vertical or oblique photography. Three distinct modes of day operation and a primary and secondary mode of night operation are



PH.460

1. Latch.
2. Cable stowage clamp.
3. Carrying case, lid portion.
4. Light source stowage clamp.
5. Test cable.
6. Locking device.
7. Access cover.
8. Control panel.
9. Breather valve (relief valve).
10. Hinge pin.
11. Test cable stowage compartment.

Figure 8-26.—LS-83A, Integrated Test Set.

provided. Selection of the mode of day operation and the primary mode of night operation can be accomplished manually by a remote switch located in the aircraft cockpit. All modes of operation can be selected by a control on the camera. Power and control voltages are required from an aircraft camera control system in order to operate the camera.

Description

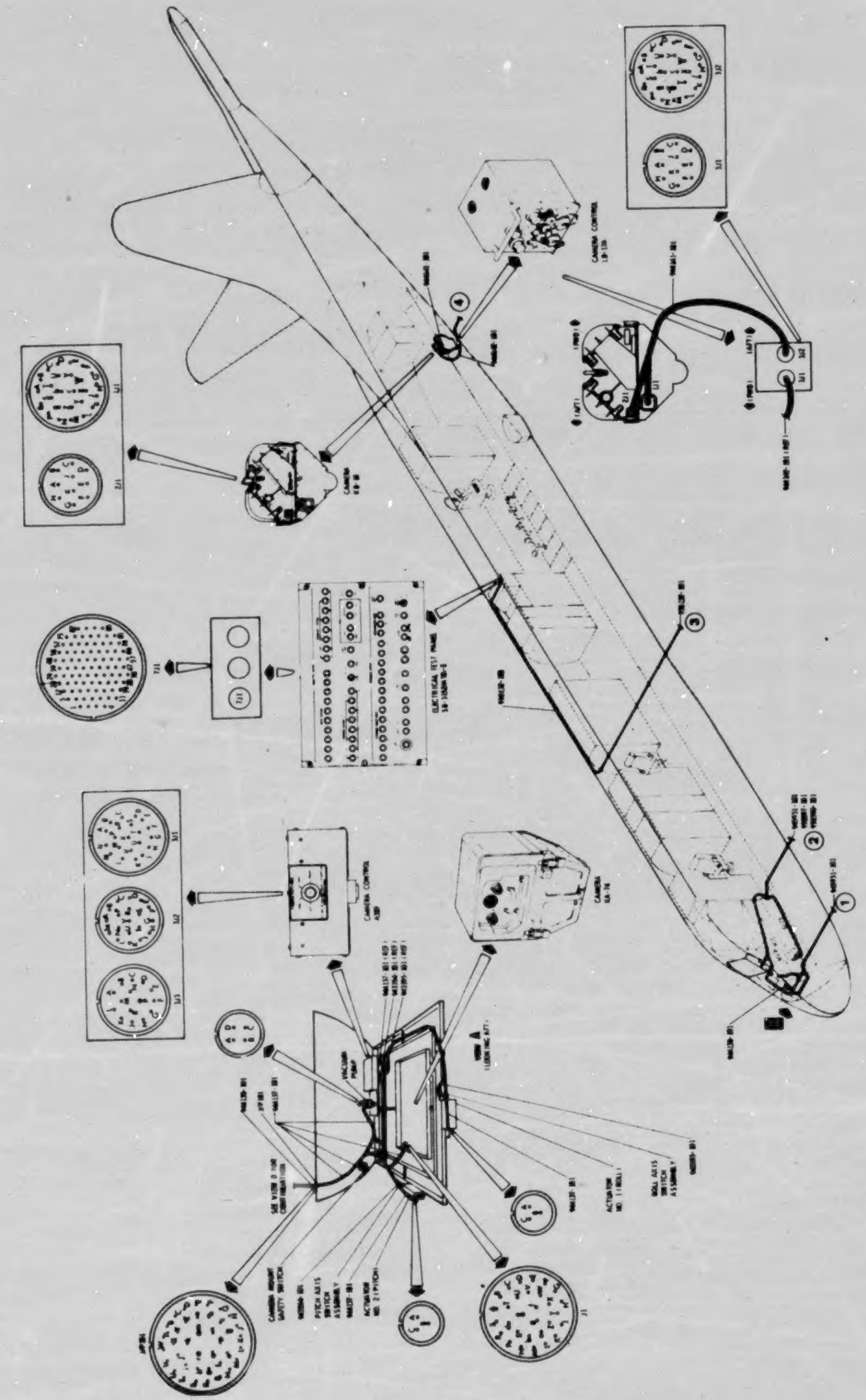
The KA-45A camera consists of five separate detachable components—camera body (body drive), lens cone, shutter mechanism, and one "Supply" and one "Takeup" film magazine cassette, Type LA-141A. The shutter mechanism and the cassettes are attached to the camera body, and the lens cone is attached to the shutter mechanism to form an operational camera. Figure 8-29 shows the camera assembled for operation.

CAUTION: The lens cone, shutter mechanism, and the camera body for each camera are matched and are not interchangeable with components of other cameras.

The camera has a 6-inch lens with aperture settings ranging from f/2.8 to f/6.7 and a focal plane shutter with speeds ranging from 1/60 to 1/3000 second. The film cassette will accommodate a maximum of 250 feet of 5-inch film which provides approximately 600 exposures 4½ x 4½ inches in size.

Film Cassettes

The cassettes (fig. 8-30) permit handling up to 250-foot rolls of fresh or exposed film. Cassettes having a capacity of 100 feet can be used in installations where space is very limited. In operation the cassettes support the film spools, provide the drive coupling, and perform the film supply and takeup functions. Each cassette includes a cover and cassette body. A FEET REMAINING indicator is placed on one end of the cassette body and indicates the amount of film remaining in the supply cassette. Two spring locks secure the cover to the cassette body. The cover contains a white vinylite data card, which is used for any necessary pencil



PH.461

Figure 8-27A.—P-3C aircraft, photographic systems, cable and connector diagram.

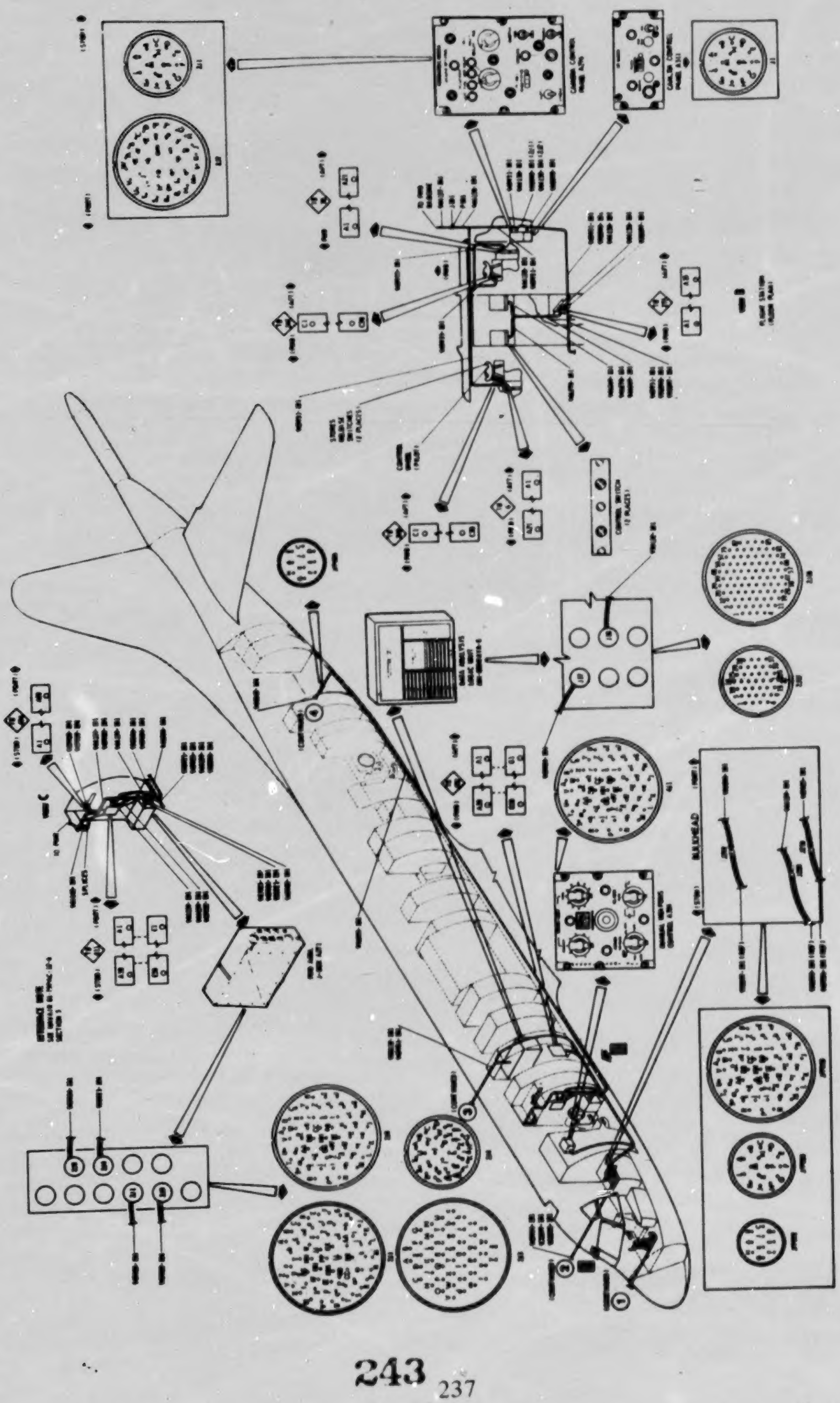
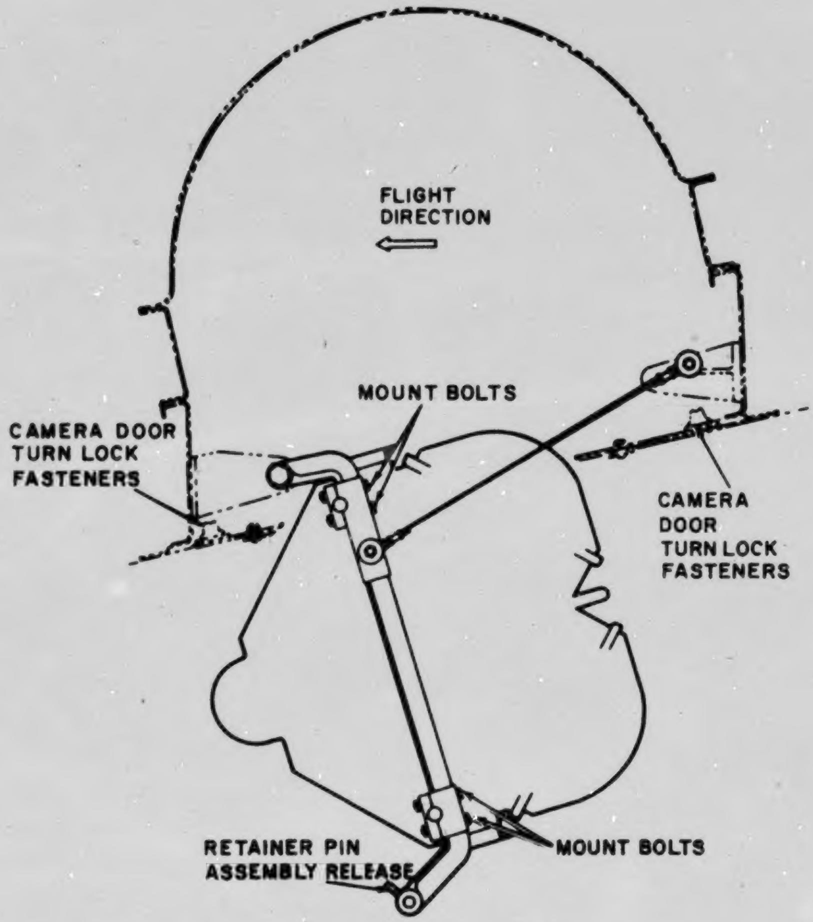


Figure 8-27B.—P-3C aircraft, photographic systems, cable and connector diagram.

PH.461


FLIGHT DIRECTION
MOUNT BOLTS
CAMERA DOOR TURN LOCK FASTENERS
CAMERA DOOR TURN LOCK FASTENERS
RETAINER PIN ASSEMBLY RELEASE
MOUNT BOLTS

PH.462

Figure 8-28.—KB-18A camera removal from P-3C aircraft.

notations. A pivot support, pivot lock, and pivot drive assembly are placed in the center of each end of the cassette body. The pivot drive assembly supports and drives the film spool within the cassette. The pivot drive assembly has gears built into it which adjust the speed of the film spool for proper takeup. It should be noted that there is a difference in diameter of the film spool covers for the 100-foot rolls and the 250-foot rolls. For proper operation of the takeup spool, a 250-foot spool must always be used in the 250-foot takeup cassette. A 100-foot film spool may be used in the 250-foot cassette without affecting operation. The pivot lock holds the pivot support in place by being interlocked to the cover. Thus, the pivot support cannot become unseated unless the cover is removed.

Film Loading

Before loading the film, separate the cassettes from the camera body. Separation of the camera body, shutter mechanism, and lens cone is not required. Place the camera upright on a clean, flat surface with the right side towards the

Table 8-2.–Characteristics of the KA-40A, KA-45A, and KA-46A Cameras.

Camera designation:	KA-40A	KA-45A	KA-46A
Primary use:	Day/night recon.	Same as KA-40A	Same as KA-40A.
Format size:	4.5 x 4.5 inches.	"	"
Film width:	5 inches.	"	"
Film length:	250 ft LA-141A magazine.	"	"
	100 ft LA-135A magazine.	"	"
Focal length:	3 inches.	6 inches.	Same as KA-45A.
Max. apt.:	4.5	2.8	"
Angular coverage:	73°44′	41°06′	"
Shutter speed:	1/50–1/800	1/60–1/3000	1/50–1/400
Shutter type:	Between the lens.	Focal plane.	Same as KA-40A.
Remarks:	Manual exposure control or remote control when used in the RF-8G or RA-3B type aircraft.	Same as KA-40A.	Lens cone exposure control.

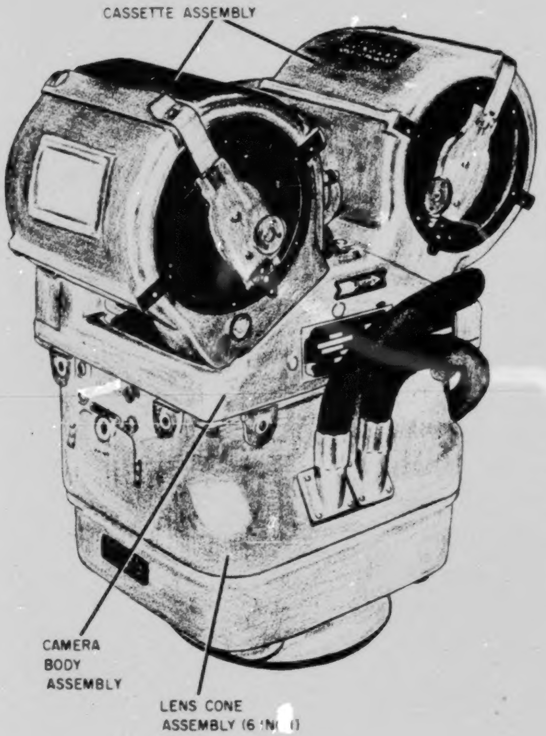
photographer, and remove the cassettes as follows:

1. Depress the cassette latchbolt and pull the cassette latch outward to its stop (fig. 8-30).
2. Pull out the rear spring-loaded coupling drive knob while removing the cassette from the supply cassette position on the camera body.
3. Pull out the front coupling drive knob and remove the cassette from the takeup cassette position on the camera body.

Remove the cover and film spool from the cassette body (fig. 8-30) as follows:

1. Release the spring locks which secure each end of the cover assembly to the cassette body and remove the cover.
2. Push up both pivot locks (one on each end of the cassette body) to unfasten the pivot support and the pivot drive assembly.
3. Grasp the spring locks and firmly pull them away from the cassette body. The pivot support and the pivot drive assembly will swing out, releasing the film spool.
4. Lift film spool up and out of the cassette body.
5. Examine the pivot locks. Each should be securely held in the raised position by its pivot lock spring. With the cassette in an upright position (pivot locks upward), swing the pivot supports upward and against the ends of the cassette body; each pivot lock should drop down freely to lock the pivot supports.

It is recommended that the cassette be loaded in a totally dark room. Load the cassette–which is selected to hold the film supply–as directed in the steps below. Either cassette may be used for



PH.463

Figure 8-29.—KA-45A camera assembled.

this function since they are identical except for their installed position.

1. Place the cassette body on a clean, flat surface with the latching lip upward, and the FEET REMAINING indicator to the right and facing the photographer.

2. Unwind approximately 12 inches of leader from a fresh roll of film. Cut the leader end to form a wide-angle point to facilitate film threading. Position the roll of film to the left of the cassette with the leader unwinding clockwise toward the cassette body.

3. Grasp the end of the film leader with the left hand, and hold the cassette body with the right hand, placing the thumb beside the latching lip and the fingers on the bottom. Feed the film leader with the left hand, guiding it along the upper interior surface of the cassette body until several inches of leader emerge from the light lock on the bottom.

4. Tip the cassette body onto the light lock, pick the film spool up with right hand, and lay slack leader to the left of the body assembly. Lower the film spool into the cassette body while drawing leader to left with the left hand.

5. Swing both pivot supports upward. Press firmly inward on both pivot supports and turn the film spool slowly counterclockwise until the pivots enter the holes in the film spool and both pivot locks drop into place.

CAUTION: If the pivot locks are not fully raised at this time, the cover may be replaced without the pivots fully entering the film spool, and without the pivot supports being properly in place against the end of the cassette body. If a cassette is installed on the camera body in this condition and the camera operated, serious damage to the camera body and cassette may result.

6. Pull about 3 feet of leader through the light lock. Install the cover cassette on the cassette body and secure it with the spring locks at both ends. The cover is symmetrical and needs no orientation.

Loading Camera Body

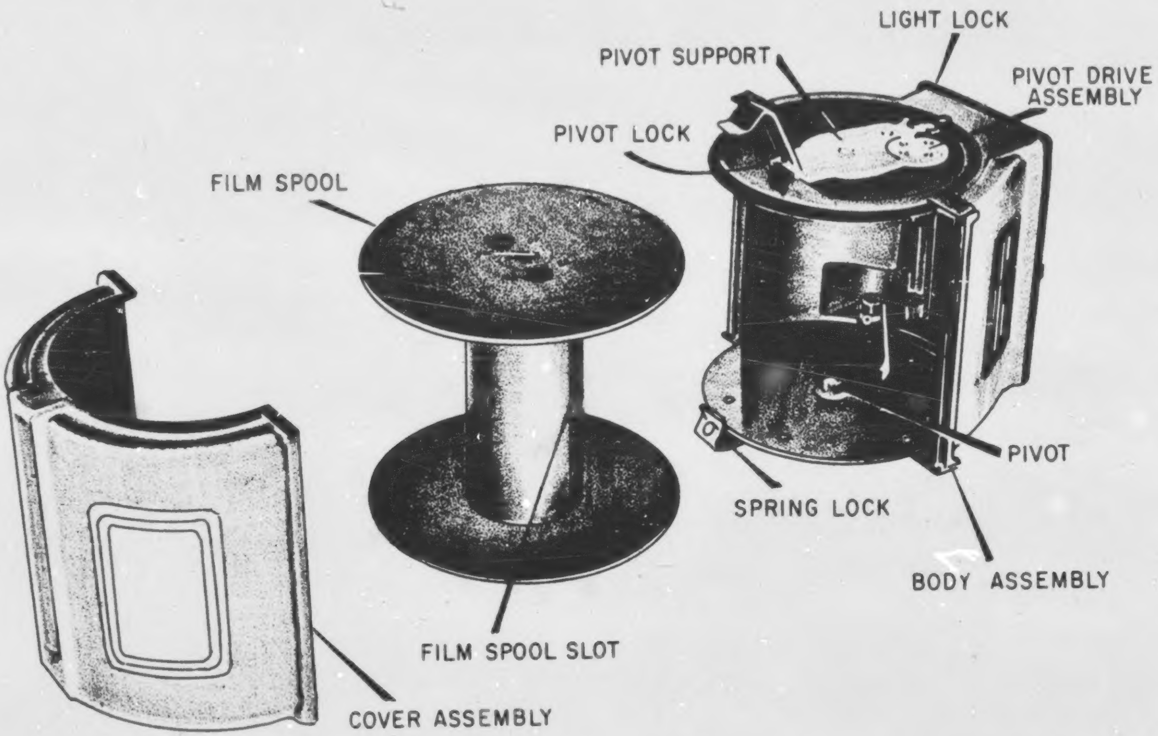
The cassettes are lighttight and the following steps can be performed under normal daylight conditions. (See fig. 8-31.)

1. Place the camera upright on a flat, clean surface so that the threading lever is to the right. Set the loaded cassette with the FEET REMAINING indicator facing the photographer to the left of the camera body, and with the leader laid toward the camera body.

2. Press down and turn the threading curtain lever three-fourths turn clockwise until it snaps up.

3. Swing the idler roller upward and to the left. Pass the film leader end over the idler roller. Thread the film leader end to the left, over the top of the rear shuttle roller and push into the camera body.

4. Push the film leader through the camera body until it appears in the opening on the takeup side of the camera body. Pull out 4 to 6 inches of film leader, making sure it passes through the camera body smoothly with no binding. Then swing the idler roller inward and down.



PH.464

Figure 8-30.–Cassette cover and film spool removal.

5. Push the film leader under the film guide-lip of the film guide until it appears at the top of the metering roller. Pull slack leader through the camera body.

6. Push downward on the pressure roller to move it away from the metering roller, and push the film leader down and to the right between the metering and pressure rollers, and the stainless steel film guide.

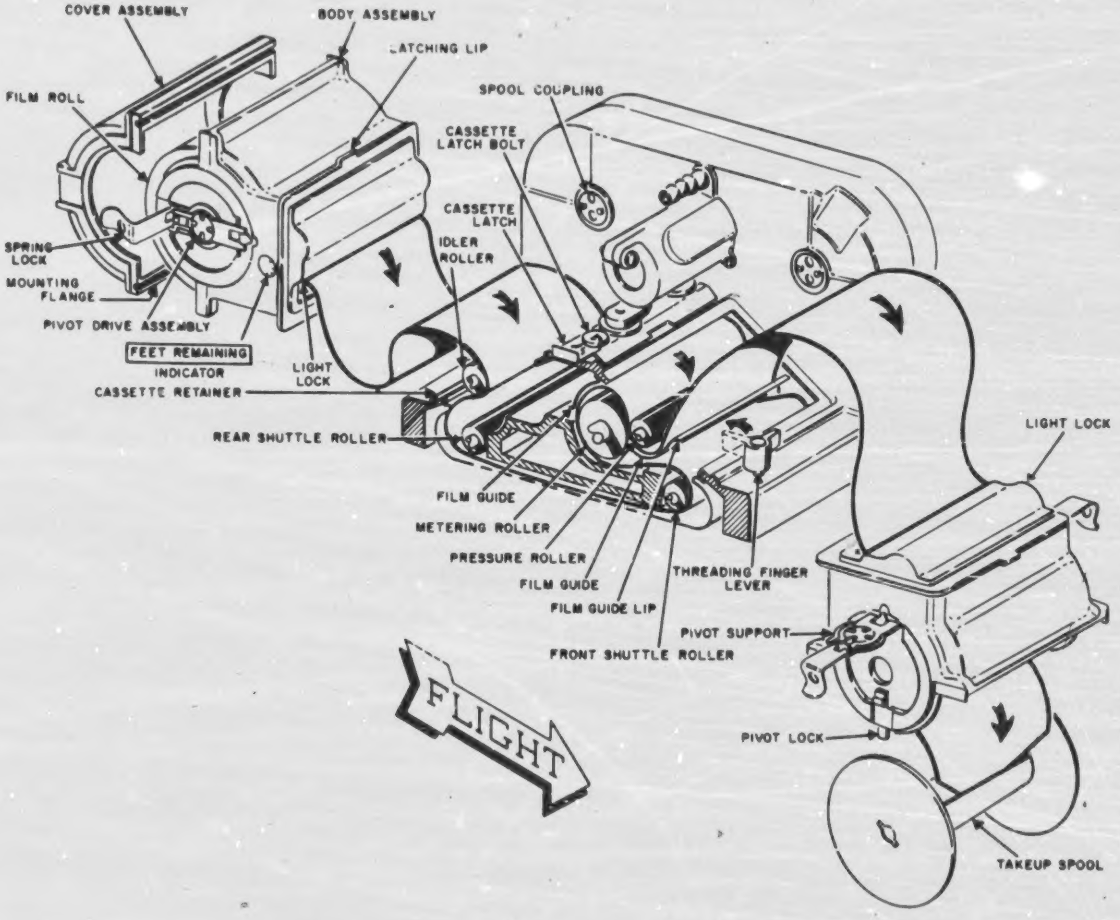
7. Pull a few inches of film leader out of the camera body. Depress the threading curtain lever. The threading curtain will retract automatically. The threading lever must return to a position parallel to the front of the camera body.

8. Push down on the cassette latchbolt on the camera body and pull the latch forward to its stop.

9. Pick up the loaded cassette in the left hand, and while moving it toward the camera body, pull the slack film through the camera body with the right hand. Install the cassette in the supply position on the camera body by hooking the mounting flange of the cassette under the cassette retainer on the camera body. Pull out and hold the supply coupling drive knob on the camera body. Swing the cassette to the right until it seats on the camera body. Then press the cassette down into the mating recess until the latching lip is below the cassette latch. Release and turn the coupling drive knob until the spool coupling engages the pivot drive on the cassette and the drive coupling snaps into place.

10. Set the takeup cassette to the right of the camera body, placing the cassette so that the FEET REMAINING indicator faces away from the photographer.

11. Release both spring locks and remove the cover assembly. Check to insure that the empty film spool is properly seated on the pivots, and that the spool flanges are not bent.


COVER ASSEMBLY
BODY ASSEMBLY
LATCHING LIP
FILM ROLL
SPOOL COUPLING
CASSETTE LATCH BOLT
CASSETTE LATCH
IDLER ROLLER
SPRING LOCK
MOUNTING FLANGE
PIVOT DRIVE ASSEMBLY
FEET REMAINING INDICATOR
LIGHT LOCK
CASSETTE RETAINER
REAR SHUTTLE ROLLER
LIGHT LOCK
FILM GUIDE
METERING ROLLER
PRESSURE ROLLER
FILM GUIDE
FILM GUIDE LIP
THREADING FINGER LEVER
PIVOT SUPPORT
FRONT SHUTTLE ROLLER
FLIGHT
PIVOT LOCK
TAKEUP SPOOL

PH.465

Figure 8-31.—Film loading procedure.

12. Push the film leader end through the light lock into the cassette body. Thread the film to the left of the film spool (latching lip side).

13. Check the camera body to make sure that the cassette latch is forward against its stop. Pick up the cassette in the left hand. Hold the film leader with the right hand and move cassette to the left along the film to the camera body. Hook the mounting flange of the cassette body under the cassette retainer in the takeup opening of the camera body. Swing the cassette body to the left until it seats on the camera body.

14. Press both cassettes down until their latching lips are below the cassette latch. Push in on the latch until the cassette latchbolt snaps up.

CAUTION: Do not force the cassette latch. If the cassette latchbolt does not snap up, pull cassette latch out to its stop. Reseat the cassettes and relatch properly.

15. Insert the film leader end into the slot of the film spool and attach it to the spool core with a piece of tape. Wind slack film clockwise on the spool. Install the spool into the cassette body and latch pivot.

16. Turn the takeup coupling drive knob on the camera body until the spool coupling engages with the pivot drive of the takeup cassette

and the coupling drive knob snaps into place. Then turn the film spool clockwise until all slack film is taken up. Install the cover assembly and secure with both spring locks.

Filters

Yellow and red filters are provided with the camera. The filter selected for use is secured to the lens cone assembly by the same bayonet mount which secures the front-element lens cap.

Operation

The camera operates from power and control voltage constants supplied from components of an aircraft camera control system. The camera may be operated in the AUTOCYCLE, PULSE, IMC PULSE, PRIMARY NIGHT (Electronic Flash), or SECONDARY NIGHT mode of operation. The desired mode of operation may be selected by the mode selector switch on the camera before takeoff. Since the camera is designed for in-flight operation by remote control, all operating instructions performed on the camera are preflight or postflight operations.

Preventive Maintenance

No lubrication is to be performed by maintenance personnel on this camera. The camera is lubricated during fabrication by the manufacturer. Additional lubrication is not required or desirable during the first 5 years of shelf life, or 20,000 cycles of operation (whichever occurs first); after this period the camera is lubricated during overhaul.

Additional information on the KA-45A camera may be found in its Operation and Maintenance Instructions Manual, NavAir 10-10AC-525.

KA-50 FAMILY OF CAMERAS

With the rapidly changing world situation, some way of incorporating pertinent data with the photographic image had to be developed. The KA-50 series cameras were the result, along with the sophisticated system, used to furnish all the necessary information to be recorded on the film. The camera control and data system for these cameras will be discussed under the chapters covering these items.

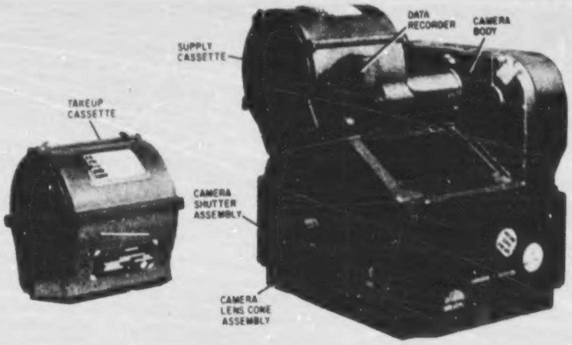
All KA-50 series cameras are basically the same; therefore, to prevent needless duplication, only pertinent data will be given on the KA-50A and KA-51B, and the detailed coverage on the KA-53A can suffice as an introduction to the entire KA-50 family.

Figure 8-32 shows the KA-50A and table 8-3 lists some of the leading particulars of the camera. Figure 8-33 shows the KA-51B and table 8-4 lists some of its leading particulars.

KA-53A RECONNAISSANCE CAMERA

The camera, still picture type KA-53A, illustrated in figure 8-34 is a high acuity aerial reconnaissance serial frame camera capable of taking exposures during day or night. Image motion compensation (IMC) capability is provided, allowing operation within a wide range of aircraft terrain clearance and groundspeeds.

The camera may be mounted for either vertical or oblique photography. Three distinct modes of day operation and two modes of night operation can be obtained by use of a remote switch located in the camera control system (ACCS). For emergency operation or use with a limited ACCS, the mode selector switch located inside the camera body can be used for selecting the mode. Night Open Shutter mode selection requires a manual setting of the CURTAIN

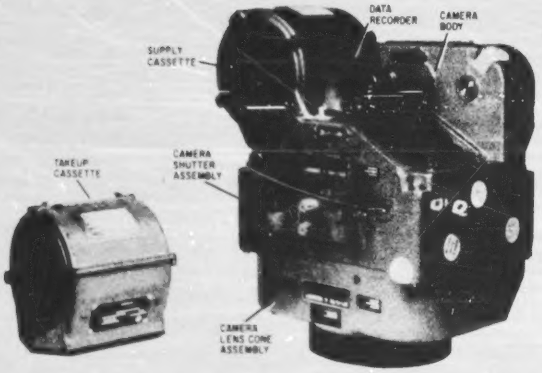


PH.466

Figure 8-32.—KA-50A camera.

Table 8-3.–KA-50A leading particulars.

Use	Day/night reconnaissance.
Aircraft	RA-5C, RA-3B, and RF-8G.
Recycle time	Maximum of 6 per second dependent upon operating mode.
Lens	1 3/4-inch, f/5.6 (fixed) with permanent anti-vignetting filter attched.
Shutter	Focal plane (metal curtain type).
Cassettes	LA-141A (250 feet, 600 exposures). LA-135A (100 feet, 240 exposures).
Format	4.5 x 4.5 inches.
Operation	Navy Camera Control System.
Special features	IMC, Integral AEC, (Data Matrix in RA-5C).
Reference	NavAir 01-60ABC-2-1C.1.



PH.467

Figure 8-33.–KA-51B camera.

LATCH. Power and control voltages are required from an ACCS to operate the camera. Also, an external vacuum source is needed. These items will be covered in more detail under the operation section of this camera.

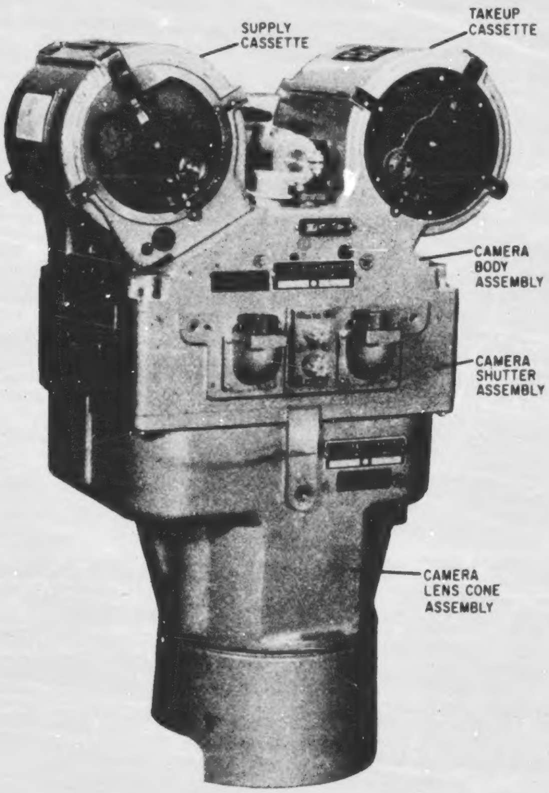
Table 8-4.–KA-50A leading particulars.

Use	Day/night reconnaissance.
Aircraft	RA-5C, RA-3B, and RF-8G.
Recycle time	Maximum of 6 per second dependent upon operating mode.
Lens	6-inch, f/2.8 (fixed)
Shutter	Focal plane (metal curtain type).
Cassettes	Same as those used on KA-50A.
Format	4.5 x 4.5 inches.
Operation	Navy Camera Control System.
Special features	Refer to KA-50A camera description.
Reference	NavAir 10-10AZ-110, NavAir 01-60ABC-2-10.1.

The data recorder is a sealed assembly which includes a cathode-ray tube (data tube) fitted with a fiber optic faceplate and an electrical connector. This assembly is commonly referred to as a CRT. Power and data circuits for the data tube must be provided by a source outside the camera. The external data circuits are triggered by a cam-actuated data trip switch in the camera body to supply data signals to the data tube each time the camera cycles. The data tube image is projected through the base of the film to the emulsion. Four fiducial marks, machined into the film format shield, are photographically recorded on each frame of film. These marks enable the photointerpreter to determine the exact center of the photograph.

Cassettes

The cassettes permit handling rolls of film up to 250 feet long (standard base) and approximately twice that amount when using thin base film. In operation, the cassettes support film spools, provide drive coupling, and perform film "supply" and "takeup" functions. Each cassette



PH.468

Figure 8-34.–KA-53A camera assembled for operation.

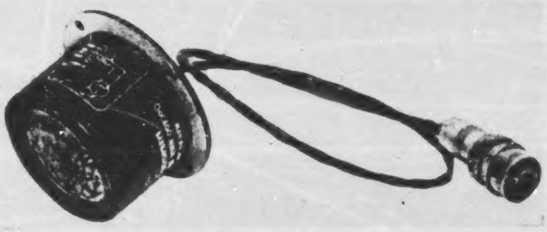
includes a cover and a body. A FEET REMAINING indicator on one end of the body indicates the amount of film remaining in the supply cassette.

LIGHT SENSOR

The light sensor (fig. 8-35) monitors terrain brightness and provides a signal voltage (reference voltage) to the exposure control circuit in the lens cone. The signal voltage is developed by a photocell in the light sensor which responds to light reflected from the terrain.

OPERATION

The camera operates from power and control voltage constants supplied by components of an aircraft camera control system (ACCS).



PH.469

Figure 8-35.–Light sensor.

Modes of Operation

The camera may be operated in any of the five modes described below:

1. Autocycle Mode. In the autocycle mode of operation, exposures are made automatically at IMC film speed with 60 percent overlap. Film movement into the camera is continuous at 2.7 times IMC rate. Film movement across the platen is reduced to IMC rate during the exposure interval by shuttle action. The shutter speed and the diaphragm opening, variable throughout the camera exposure range, are set automatically according to the terrain brightness monitored by the light sensor.

2. Night Electronic Mode. Operation of the camera is the same as in autocycle mode except that a camera-actuated switch in the camera body triggers electronic flash circuits in the ACCS to produce flash illumination in the interval during which the slit of the focal plane shutter is crossing the format opening. All exposures are made with the shutter operating at its slowest speed and with the diaphragm in its fully-open position.

3. Pulse Mode. In pulse mode operation, an exposure is made each time a cycle pulse from ACCS is applied to the camera. The camera then recycles and the film remains stationary between exposures initiated by subsequent cycle pulses. Variable overlap is obtained by adjustment of the cycle pulse rate of the intervalometer in the ACCS.

4. IMC Pulse Mode. Operation is the same as in pulse mode except that during exposure, film moves through the camera at the IMC rate.

5. Night Open Shutter Mode. In this mode, camera body operation is the same as in IMC pulse mode. The CURTAIN LATCH in the shutter must be set to OPEN which locks the trailing curtain in the open position and only the leading curtain is permitted to move. The curtain latch also actuates the DAY-OPEN switch which is located inside the shutter mechanism. The leading curtain is open (run down) at all times except during film recycle. The shutter is automatically set to its slowest speed, the diaphragm is set to its fully-open position, and the shutter remains open between exposures. A pulse from the ACCS intervalometer to the photoflash ejector causes a flash cartridge to be ejected. When the photoflash cartridge explodes to make an exposure, the flash is detected by the flash detector which initiates a pulse to the night timer. The night timer applies a shutter close pulse to the camera, causing the leading curtain to close, the camera to recycle, and the leading curtain to reopen in readiness for the next flash.

Mode Selection

Mode of camera operation may be selected by either of two mode selector switches. If the ACCS is equipped with a remote mode switch, the mode selector switch in the camera body is left in the AUTO-REMOTE position. The remote switch can then be used to operate the camera in the autocycle mode, or used to override the mode selector switch in the camera body to remotely select any other mode. If the ACCS does not include a remote mode switch, the mode selector switch in the camera body is set during preflight procedures for the desired mode of operation.

Film Cassettes and Loading

Film loading in the KA-53A camera and all other KA-50 series cameras is the same procedure as that used for loading the KA-45A camera. Refer to the section of this chapter covering the KA-45A for this information.

MAINTENANCE

Only qualified camera repair personnel should attempt maintenance on the KA-53A and other cameras in the KA-50 family, except minor repairs that can be performed without disassembly of the equipment or specialized shop test and calibration equipment.

Preventive Maintenance

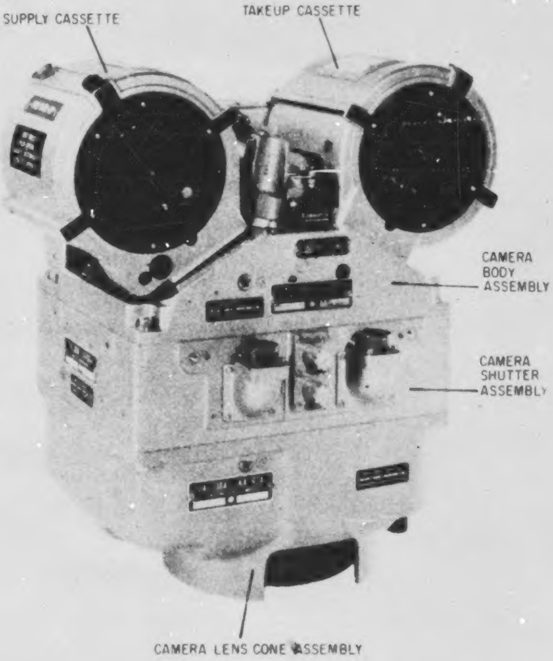
The cleaning and preventive maintenance procedures are the same as for the KA-45A with some minor differences, as follows:

1. Light Sensor—check window for dust daily.
2. Data Recorder—clean monthly.

Refer to the Operation and Maintenance Instruction Handbook, NavAir 10-10AC-103, which contains complete information on these and other procedures.

KA-62A RECONNAISSANCE CAMERA

The KA-62A reconnaissance camera (fig. 8-36) is similar in nearly all respects to the



PH.470

Figure 8-36.—KA-62A camera.

cameras of the KA-50 family of cameras. Compare it with the KA-50 family in figures 8-32 and 8-33 and the relationship is apparent.

The major function of the KA-62A is to make possible the obtaining of photographs of a larger scale than is possible with the KA-50A (1 3/4-inch) camera, at the same altitude. Table 8-5 gives some leading particulars on the KA-62A.

KS-87A DAY/NIGHT AIRCRAFT RECONNAISSANCE CAMERA

Another FRAME type aircraft camera that Photographer's Mates may come in contact with is the KS-87A aircraft camera. Although this camera is used primarily by the United States Air Force, it is also used in Marine Corps aircraft, and therefore it is conceivable that at some time Navy personnel may be called upon to service these cameras. It would therefore be wise for Navy Photographer's Mates to be familiar with the leading particulars of the KS-87A.

Table 8-5.–KA-62A camera leading particulars.

Use	Designed for day or night photographic reconnaissance.
Aircraft	RA-5C, RA-3B, and RF-8G.
Recycle time	Maximum of 6 per second dependent upon operating mode.
Lens	3-inch, f/4. 5.
Shutter	Focal plane (metal curtain type).
Cassettes	LA-141A.
Format	4. 5 inch x 4. 5 inch.
Operation	Navy Camera Control System.
Special features	Refer to KA-50A camera description.

This camera is similar in many respects to the KA-50 series cameras and the KA-62A and KA-53A cameras, which are manufactured by the same company. By comparing the leading particulars of the KS-87A and the other cameras mentioned, one can readily see their similarity. Table 8-6 gives a listing of the leading particulars of the KS-87A and tables 8-1 through 8-3 give the particulars of the KA-50, KA-51, and KA-62, in that order.

PANORAMIC AIRCRAFT CAMERAS

Among the newer types of aerial reconnaissance cameras in use by the Navy is the PANORAMIC aircraft camera. There are several versions of this type of camera in use by aerial reconnaissance squadrons of the Navy, two of which will be discussed. One is designed for low altitude, high-speed reconnaissance, and the other is designed for high altitude operation. The fundamentals of the two cameras are similar, but the differences can be seen in the information to follow. The two cameras that

Table 8-6.–KS-87A camera leading particulars.

Use	Designed for day or night photographic reconnaissance.
Aircraft	RF-4B.
Recycle time	Maximum of 6 per second.
Lens	3-inch, f/4. 5; 6-inch, f/2. 8; 12-inch, f/4. 0; 18-inch, f/4. 0.
Shutter	Focal plane (Day) and between the lens (Night).
Cassettes	LA-354B (Roll film 5-inches x 500 feet).
Format	4. 5 inch x 4. 5 inch.
Operation	Automatic.
Special features	Binary auxiliary data annotation system.

will be described are the KA-57A (KS-68 Panoramic Aircraft Camera System) and the KA-58A (KS-69A Panoramic Aircraft Camera System).

CAUTION: These cameras are not only complex; they are extremely expensive, and only personnel who have been specifically trained to operate and maintain them should attempt either their operation or the maintenance thereon.

KA-57A PANORAMIC AIRCRAFT CAMERA

The panoramic camera assembly (KA-57A) and camera system components, used in the RA-5C aircraft, provide horizon-to-horizon photographs on 70mm film. (See fig. 8-37.) The camera and mount are installed in either module No. 1 or module No. 2, depending upon the type of mission.

Description

The KA-57A camera (fig. 8-38) is a 3-inch (70mm, f/2.8) focal length, twin dovetail, twin lens assembly attached to the fully stabilized mount (LA-297A). (See fig. 8-39.)

Figures 8-40 through 8-44 provide details of the construction and operation of the KA-57A.

KA-58A PANORAMIC AIRCRAFT CAMERA

The panoramic camera assembly (KA-58A) and camera system components, used with the RA-5C aircraft, provide horizon-to-horizon photographs on 5-inch film. The KA-58A records images on the film in a manner similar to that of the KA-57A camera.

Description

The KA-58A camera (fig. 8-45) is an 18-inch focal length (f/4.0) twin lens, twin dovetail prism unit. The camera is a component of the KS-69A system which includes, in addition to the camera, a stabilized mount assembly, camera electronics, and control electronics assembly (used by both camera systems, KS-68A and KS-69A). The complexities of this camera are beyond the scope of this training manual. For complete information, refer to the maintenance instruction manuals listed for the panoramic camera.

Complete information about the KA-57A and KA-58A cameras and their operation can be found in the following Maintenance Instructions Manuals:

1. NavAir 01-60ABC-2-10, RA-5C Aircraft, Aerial Reconnaissance Systems.
2. NavAir 01-60ABC-2-10.1, RA-5C Aircraft, Aerial Photographic Systems—Cameras.
3. NavAir 01-60ABC-2-10.1.1, RA-5C Aircraft, Aerial Photographic Systems—Camera Systems.

Although only the KA-57A and KA-58A panoramic cameras have been covered in this section, it should be pointed out that there are many other types of panoramic cameras in use. These cameras vary in film size from 35mm to 5 inches in width and are manufactured by several different companies. Complete coverage of all makes and types of panoramic cameras would not only be confusing but impractical in view of the fact that only limited numbers of Photographer's Mates will be required to work on or maintain them, or in many cases even come in contact with them. Those Photographer's Mates who do find themselves attached to a reconnaissance squadron with this type camera will normally undergo an intensive training program on the cameras prior to being assigned to actual work on or with the panoramic system.

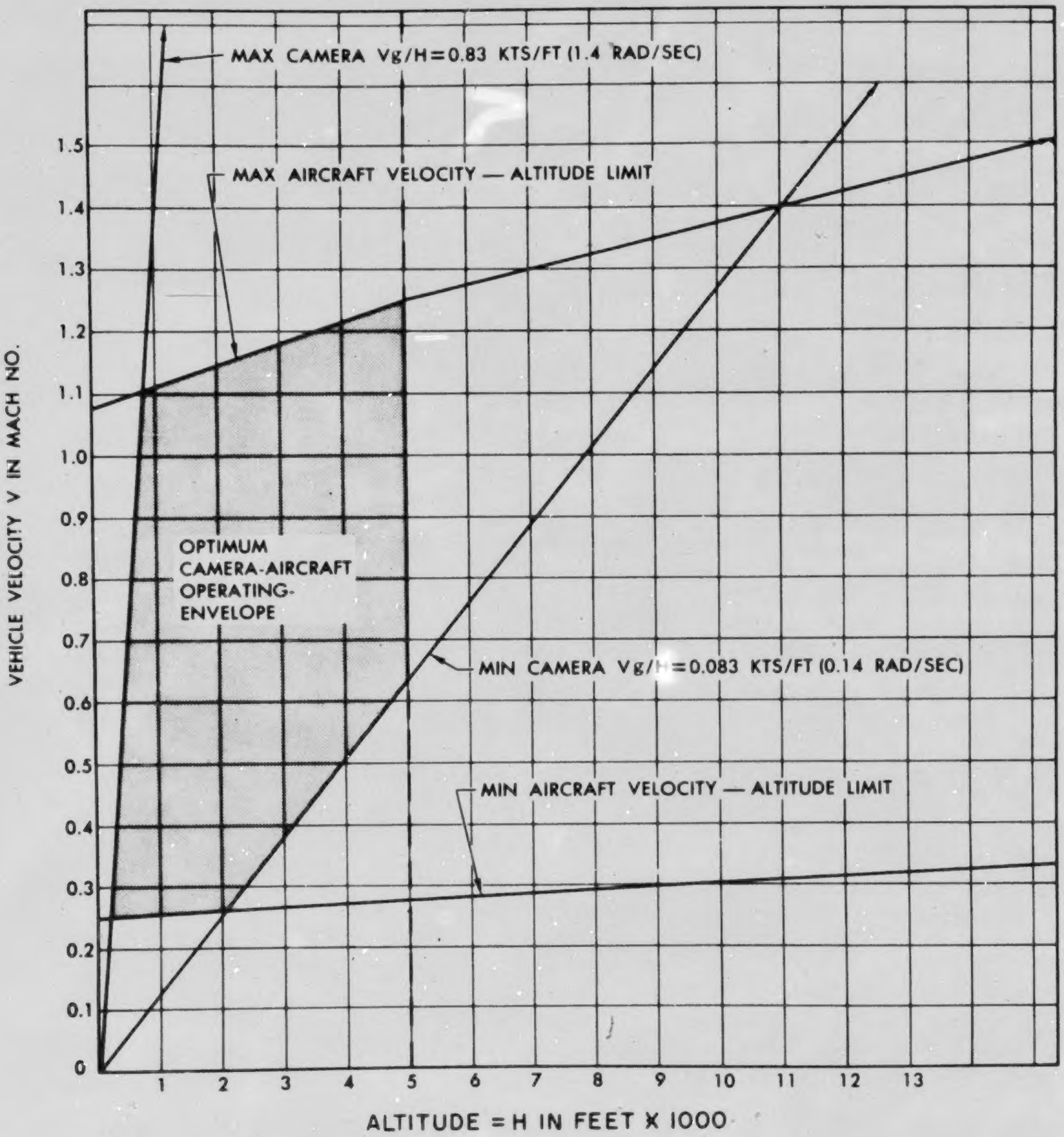
KA-74A DAY/NIGHT AERIAL SURVEILLANCE CAMERA

The KA-74A is a framing type, day/night aerial surveillance camera capable of either single picture or automatic operation. (See fig. 8-46 and 8-47)

CHARACTERISTICS OF THE KA-74A

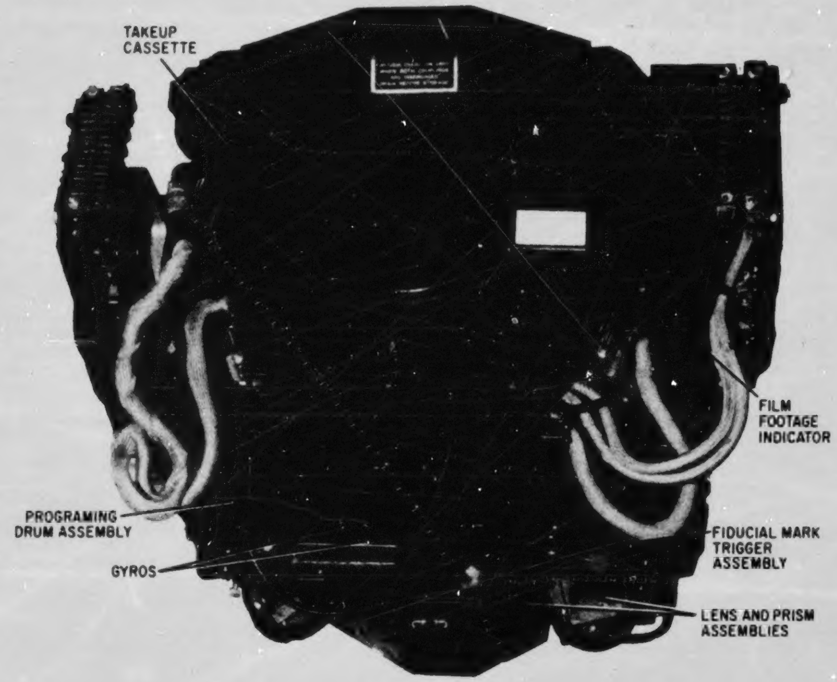
The main features of the KA-74A are listed in table 8-7.

The KA-74A is composed of a lens cone, body assembly and magazine. The easily removable magazine allows film loading without having to remove the camera from its mount.



PH.471

Figure 8-37.—Operating envelope.



PH.472

Figure 8-38.—KA-57A panoramic aircraft camera and mount.

Electrical pulses for camera operation are internally generated for normal modes of operation; aperture and shutter speeds are remotely controlled. Two shutter exposure speeds and three lens iris selections are available for day operations. In day mode the KA-74A can be operated at either 4 frames per second, 1 frame per second or as a single picture camera. (With a gear change, 2 frames per second may be obtained in lieu of 1 frame per second).

For night photography, the lens iris is opened to its largest aperture and the shutter curtain uses the night opening. When the KA-74A is placed in the night mode it can be operated at 1 frame per second or as a pulse camera. External flash equipment provides illumination for night photography, the flash equipment being triggered by a camera pulse that is synchronized with full night shutter opening (shutter in full open position).

The KA-74A is the photographic surveillance camera of the P-3C aircraft photographic system. Damage assessment photography is provided by the KB-18A camera which was covered earlier in this chapter. The KA-74A located in the nose of the P-3C is capable of taking photographs vertically, or at a 30 degree depression angle in any of three positions, forward, left, or right. Zonal image motion compensation is built in for use during low level daylight photographic missions. In the P-3C aircraft the KA-74A is used only for daylight photography. The camera, when operated, stores information needed for postflight analysis in a computer. This information includes date, time, frame number, aircraft altitude, speed, heading, posi-

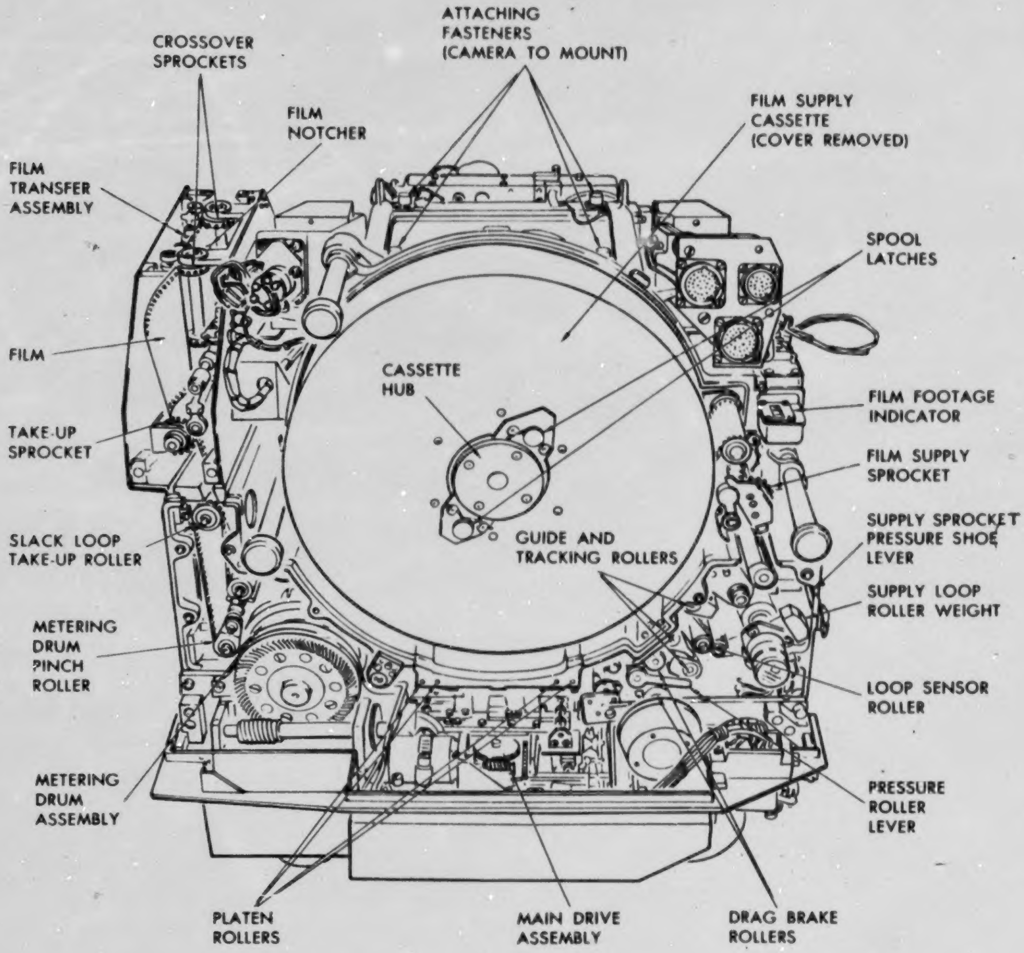

ATTACHING FASTENERS (CAMERA TO MOUNT)
CROSSOVER SPROCKETS
FILM NOTCHER
FILM SUPPLY CASSETTE (COVER REMOVED)
FILM TRANSFER ASSEMBLY
SPOOL LATCHES
FILM
CASSETTE HUB
FILM FOOTAGE INDICATOR
TAKE-UP SPROCKET
FILM SUPPLY SPROCKET
SUPPLY SPROCKET PRESSURE SHOE LEVER
SLACK LOOP TAKE-UP ROLLER
GUIDE AND TRACKING ROLLERS
SUPPLY LOOP ROLLER WEIGHT
METERING DRUM PINCH ROLLER
LOOP SENSOR ROLLER
METERING DRUM ASSEMBLY
PRESSURE ROLLER LEVER
PLATEN ROLLERS
MAIN DRIVE ASSEMBLY
DRAG BRAKE ROLLERS
PH.473

Figure 8-39.—KA-57A panoramic camera, component locator (forward side).

tion, and other additional information which can be inserted via the pilot's keyset.

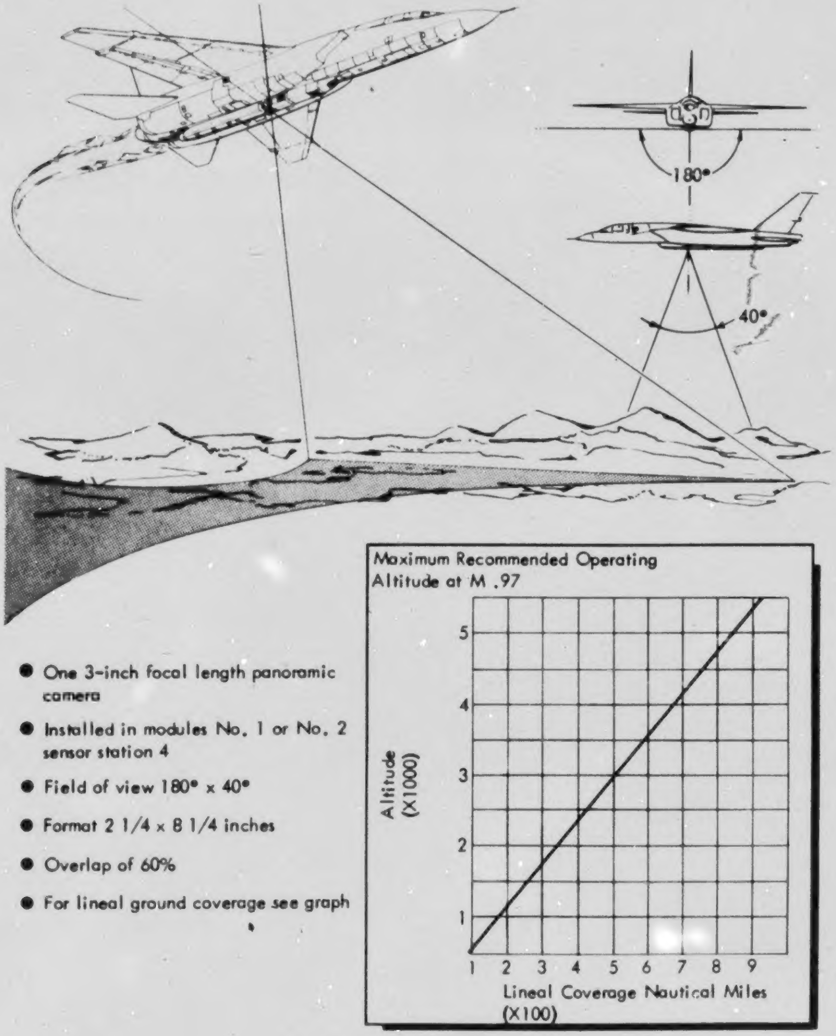
FORWARD CAMERA CONTROL BOX, A276

The KA-74A camera can be operated by either the pilot or copilot with the forward camera control box, A276, located on the copilot's console. (See fig. 8-48.)

EXPOSURE SELECTION

The KA-74A, remotely controlled, has two different shutter speeds and three iris settings. The camera iris settings listed in table 8-8 can be changed to include f/11 or f/16, to meet the needs of any particular application, with a change in wiring.

When an iris dull command is selected, the iris opens up to f/2.8 to provide the maximum


180°
40°
Maximum Recommended Operating Altitude at M .97
Altitude (X1000)
1
2
3
4
5
1 2 3 4 5 6 7 8 9
Lineal Coverage Nautical Miles (X100)

- One 3-inch focal length panoramic camera
- Installed in modules No. 1 or No. 2 sensor station 4
- Field of view 180° x 40°
- Format 2 1/4 x 8 1/4 inches
- Overlap of 60%
- For lineal ground coverage see graph

PH.474

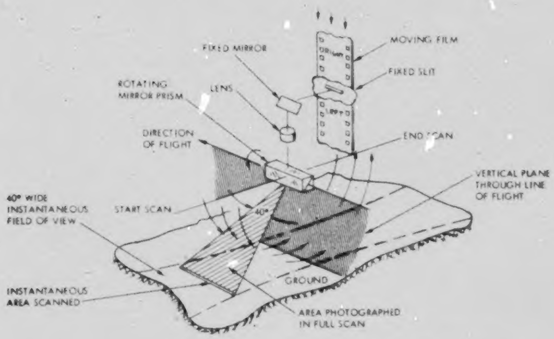
Figure 8-40.—Three-inch panoramic camera ground coverage.

opening during low light level conditions. When selecting a hazy or bright command the lens iris is changed accordingly. When a night command is applied, the lens iris automatically opens to f/2.8.

KA-74A FILM MAGAZINE

Refer to figure 8-49. Step by step procedures for removing the KA-74A magazine are as follows:

1. Pull back pawl on locking knob and rotate locking knob 90 degrees counterclockwise to unlock position.
2. Loosen adjustment ring.
3. Grasp magazine handle and pull magazine out from camera body.

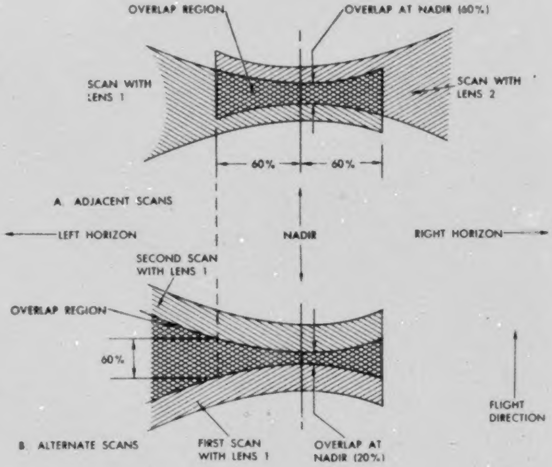

MOVING FILM
FIXED MIRROR
FIXED SLIT
ROTATING MIRROR PRISM
LENS
DIRECTION OF FLIGHT
END SCAN
VERTICAL PLANE THROUGH LINE OF FLIGHT
40° WIDE INSTANTANEOUS FIELD OF VIEW
START SCAN
40°
GROUND
INSTANTANEOUS AREA SCANNED
AREA PHOTOGRAPHED IN FULL SCAN

PH.475

Figure 8-41.—Prism scanning.

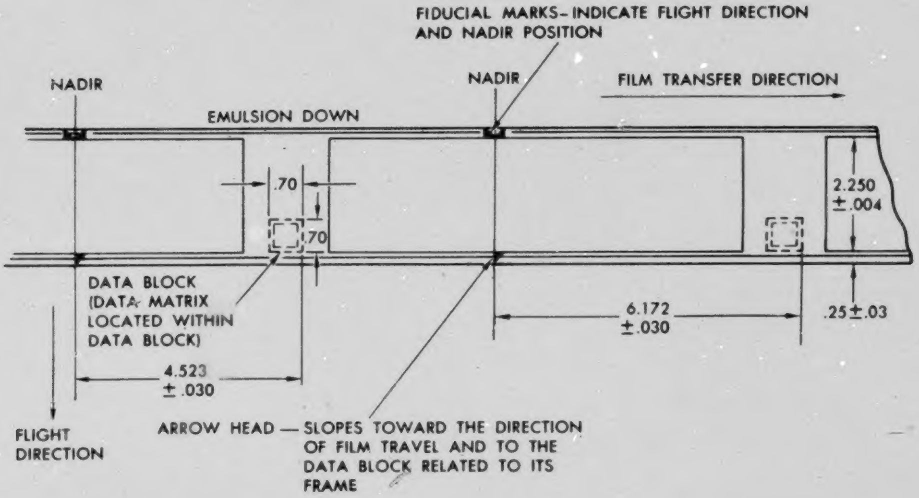
Film Loading

NOTE: Always load or unload magazine in a darkroom.


OVERLAP REGION
OVERLAP AT NADIR (60%)
SCAN WITH LENS 1
SCAN WITH LENS 2
60%
60%
A. ADJACENT SCANS
LEFT HORIZON
NADIR
RIGHT HORIZON
SECOND SCAN WITH LENS 1
OVERLAP REGION
60%
FLIGHT DIRECTION
B. ALTERNATE SCANS
FIRST SCAN WITH LENS 1
OVERLAP AT NADIR (20%)

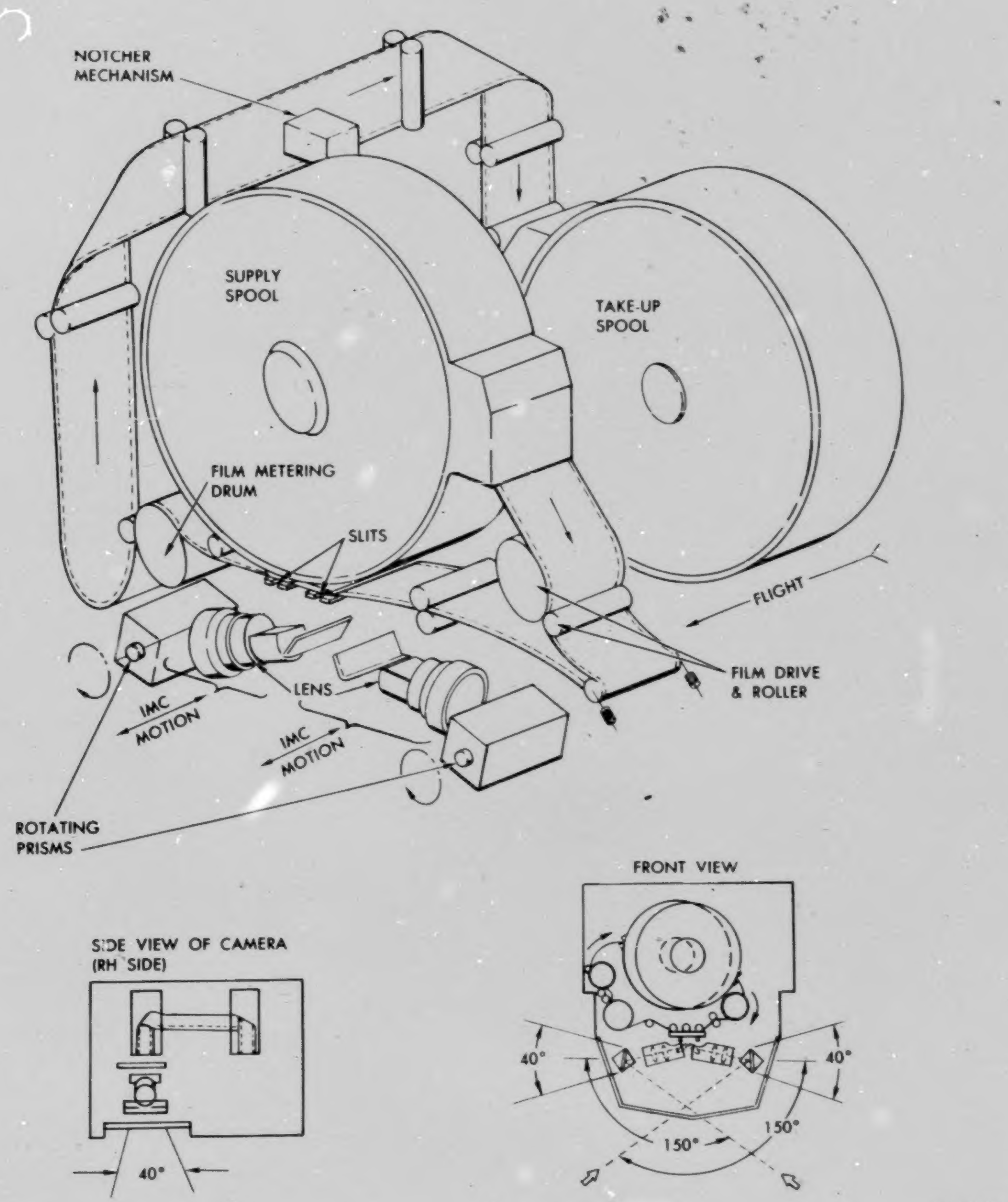
PH.476

Figure 8-42.—Film frame overlap.


FIDUCIAL MARKS—INDICATE FLIGHT DIRECTION AND NADIR POSITION
NADIR
NADIR
FILM TRANSFER DIRECTION
EMULSION DOWN
.70
.70
2.250 ±.004
DATA BLOCK (DATA MATRIX LOCATED WITHIN DATA BLOCK)
6.172 ±.030
.25±.03
4.523 ±.030
FLIGHT DIRECTION
ARROW HEAD — SLOPES TOWARD THE DIRECTION OF FILM TRAVEL AND TO THE DATA BLOCK RELATED TO ITS FRAME

PH.477

Figure 8-43.—Film frame format.


NOTCHER MECHANISM
SUPPLY SPOOL
TAKE-UP SPOOL
FILM METERING DRUM
SLITS
FLIGHT
FILM DRIVE & ROLLER
LENS
IMC MOTION
IMC MOTION
ROTATING PRISMS
FRONT VIEW
SIDE VIEW OF CAMERA (RH SIDE)
40°
40°
40°
150°
150°

PH.478

Figure 8-44.—Film path and prism scanning.

1. Loosen magazine cover lock and remove cover.

2. Place magazine so that it is resting on takeup spool side.

3. Press and turn knurled knob on supply spool lock counterclockwise until knob pops out. Pull and turn back clockwise to place knob in load position.

a. Insure that the sensitivity switch, located at side of magazine is adjusted for thin base film so that the camera can use either thin base or standard base film.

b. Insert a 3-inch square strip of thin base film on supply side of platen over the sensitivity switch actuator.

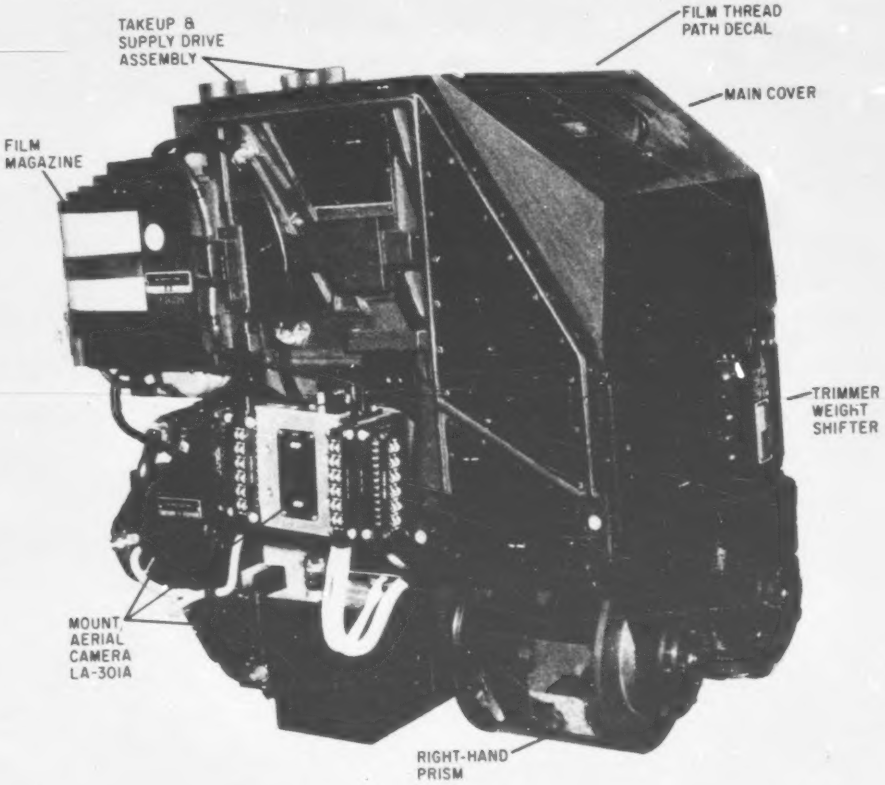
c. Adjust actuator screw on the sensitivity switch until it actuates.

d. Move film back and forth to check actuation of the sensitivity switch. If because of background noise, actuation of the sensitivity switch cannot be heard, connect ohmmeter across the sensitivity switch terminals. When the switch actuates, ohmmeter will indicate continuity.

4. Unwind approximately 3 feet of unexposed film from supply spool.

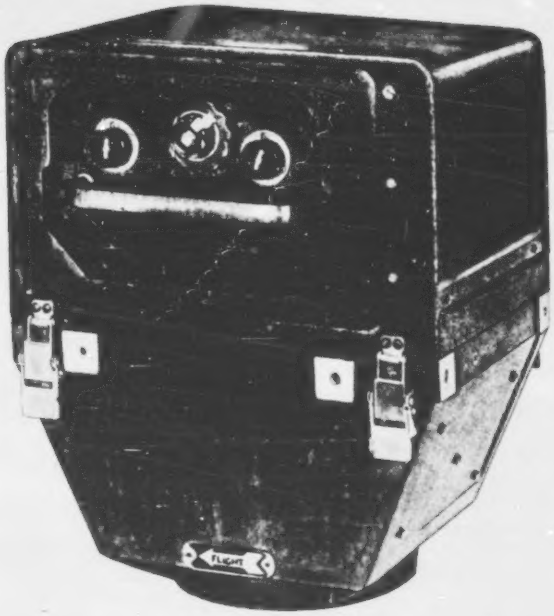
5. Place supply spool in supply position with film unwinding from bottom side of spool. Refer to film loading diagram, figure 8-50.

6. Turn knurled knob on supply spool lock counterclockwise until keys on spindle snap in place. Rotate clockwise and push forward on knob to lock spool.


TAKEUP & SUPPLY DRIVE ASSEMBLY
FILM THREAD PATH DECAL
MAIN COVER
FILM MAGAZINE
TRIMMER WEIGHT SHIFTER
MOUNT, AERIAL CAMERA LA-301A
RIGHT-HAND PRISM

PH.479

Figure 8-45.—KA-58A panoramic aircraft camera and mount LA-301A.



PH.480

Figure 8-46.—KA-74A Day/Night Aerial Surveillance Camera.

7. Cut end of film so film has centrally located pointed leading edge. Feed film over small idler roller and between large idler roller and end plate. Push leader between platen and format mask area. Place magazine upside down.
8. Crimp leading edge of film toward platen and carefully feed film across platen by pushing with fingers. Guide leading edge of film under far edge of format mask so that film enters into metering roller and pressure roller area. Place magazine on supply spool side.
9. Pull up pressure roller and continue to feed film between metering and pressure rollers. Gently pull excess film through metering and pressure rollers. Center film on metering roller before releasing pressure roller.
10. Insert film end into takeup spool slot and roll excess film onto spool. Film should roll on takeup spool as shown in the loading diagram.
11. Press and turn knurled lock knob counterclockwise on takeup spool until knob pops out. Turn back clockwise to place it in a load position.
12. Install takeup spool in takeup position.
13. Press and turn knurled knob on takeup spool counterclockwise until spindle keys snap into place. Press while rotating clockwise to lock spool.
14. Rotate takeup spool to remove all slack in film.
15. Replace magazine cover and tighten cover lock.

Film Removal

To remove the exposed film, the following procedure is given:

1. Remove magazine from camera.
2. Remove magazine cover in darkroom.
3. Turn knurled knob on supply spool lock counterclockwise until knob pops out. Turn back clockwise to place knob in lock position.
4. Remove takeup spool and place in light-tight container for processing.

KA-74A MAGAZINE INSERTION

To insert the magazine into the camera carry out the following procedures.

1. Note and record reading on cycle counter.
2. Inset magazine fully into camera, insuring guide rails mate smoothly. Hold back of camera with one hand and apply pressure to magazine with other hand so electrical connector and vacuum connectors in the magazine are fully connected.
3. After magazine is seated, turn locking knob clockwise until the pawl snaps into place. Tighten adjustment ring by turning clockwise. If both the white pawl and the white notch in the pawl locking knob can be seen, the magazine is not properly locked.

KA-74A OPERATIONAL CHECKS AND MAINTENANCE PROCEDURES

The operational check and troubleshooting procedures for the KA-74A camera provide a go/no-go indication of the camera system. These

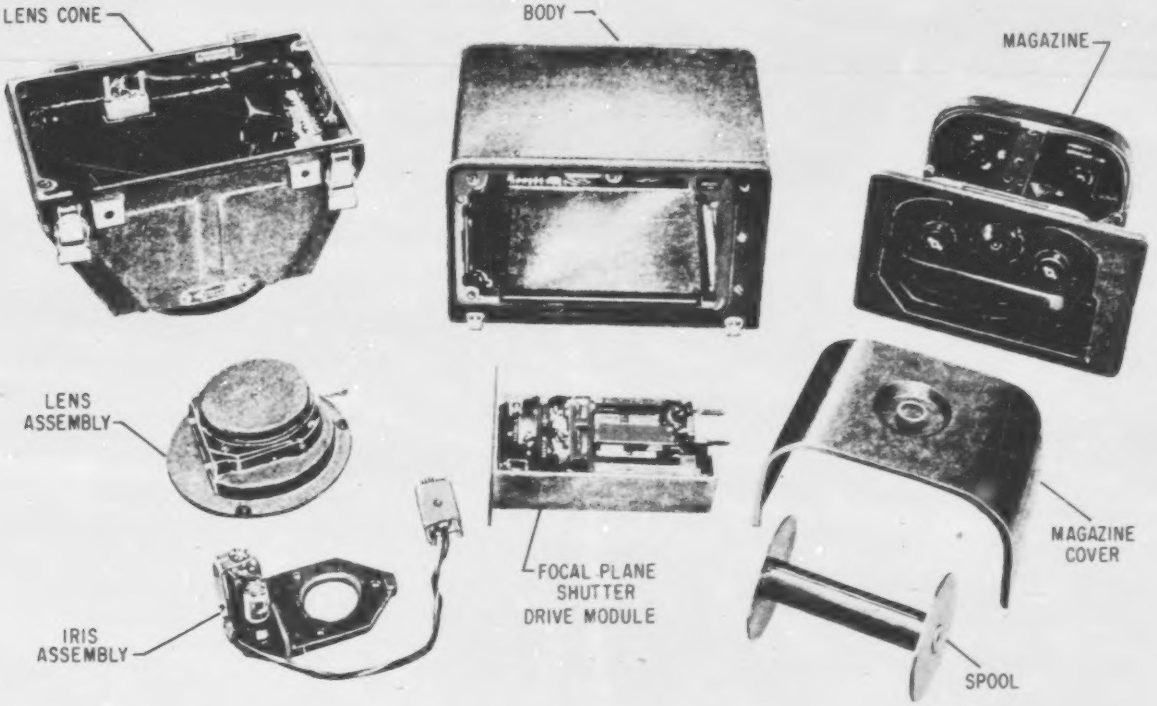
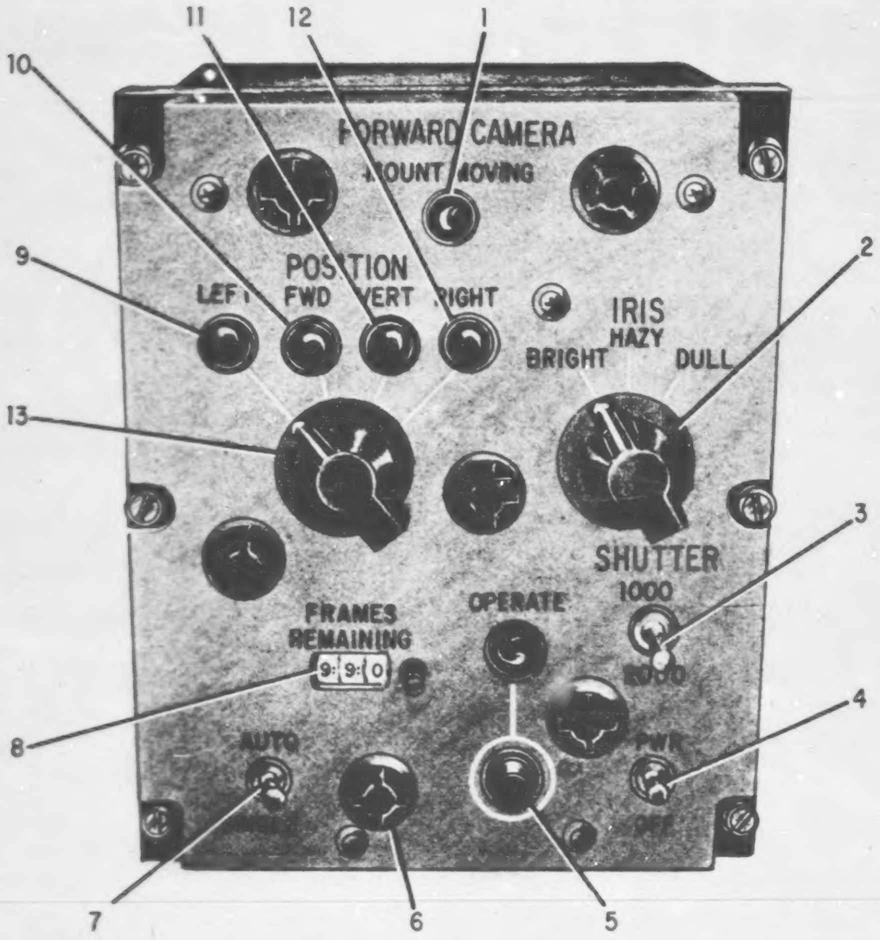


Figure 8-47.–KA-74A major components.

procedures are designed to isolate faults (defects), through a system exercise, to a replaceable component. Corrective action (maintenance) for a defective unit will generally be accomplished at the organizational level by the removal and replacement of the unit. Troubleshooting procedure for the KA-74A is based on the concept of maximum utilization of the controls and indicators of the KA-74A test equipment. This enables the photo technician to partially isolate a fault, using a minimum number of checks at major test points to pinpoint the fault(s) or defect(s) to a replaceable unit.

There are two camera test procedures for the KA-74A. These are the preflight performance check, used to test assembled cameras, and the test used to check the camera's subsystems after repair or overhaul. Troubleshooting of the camera is keyed to the use of test equipment, and troubleshooting charts. Overhaul of the camera should be performed if there are repeated troubles or erratic operation, and after 100,000 operational cycles. Detailed information regarding the use of the KA-74A test set, troubleshooting procedures, maintenance and overhaul procedures, and operational checks are found in the Maintenance Instructions Manual NAVAIR 10-10DC-16, for the KA-74A aerial camera, and the Maintenance Instructions Manual, NAVAIR 01-75PAC-2-11.1 Photographic Systems Organizational Maintenance, for the Navy model P-3C aircraft.


11
12
1
10
FORWARD CAMERA
MOUNT MOVING
9
POSITION
LEFT
FWD
VERT
RIGHT
2
IRIS
HAZY
BRIGHT
DULL
13
3
SHUTTER
1000
2000
FRAMES
REMAINING
9 9 0
OPERATE
4
8
AUTO
PWR
OFF
7
6
5

PH.482

Figure 8-48.—Forward camera control box, A276.

KA-69A DAY/NIGHT AERIAL CAMERA

The KA-69A aerial camera, a part of the KS-89A camera system, is quite similar to the KA-74A aerial camera. Therefore, only certain selected features of the KA-69A will be mentioned here. These features are selected in order to point out differences between the KA-69A and the KA-74A.

The KA-69A, often used aboard patrol type aircraft, is primarily a framing camera suitable for ASW type photography. The camera has a focal plane shutter with speeds from 1/500 to 1/2000 of a second. The maximum aperture of the 6-inch focal length lens is f/2.8. No image motion compensation (IMC) is provided. Four frames per second can be taken when the camera is operating in the autocycling mode, or single

NOMENCLATURE FOR FIGURE 8-48.

Index No.	Name	Function
1	MOUNT MOVING indicator	Indicates camera mount is in motion to selected position.
2	IRIS switch	Controls iris aperture; dependent on iris and shutter setting.
3	SHUTTER switch	Controls shutter speed.
4	POWER switch	Controls power to forward camera system.
5	OPERATE button	Controls manual operation of camera.
6	OPERATE indicator	Indicates camera is operating.
7	AUTO/SINGLE switch	Controls mode of camera operation.
8	FRAMES REMAINING indicator	Indicates number of unexposed frames remaining.
9	LEFT POSITION indicator	Indicates camera is positioned to left of aircraft centerline.
10	FWD POSITION indicator	Indicates camera is positioned along aircraft centerline.
11	VERT POSITION indicator	Indicates camera is positioned in vertical position.
12	RIGHT POSITION indicator	Indicates camera is positioned to right of aircraft centerline.
13	POSITION switch	Controls selection of one of four camera positions.
	Left	Controls camera movement to left.
	Right	Controls camera movement to right.
	Fwd	Controls camera movement to aircraft centerline position.
	Vert	Controls camera movement to vertical position on aircraft centerline.

Figure 8-48.—Forward camera control box, A276.

pictures can be taken in the pulse mode. Five hundred frames of a 2.25 x 2.25 inch negative format size can be taken on each 100 foot roll of film used in the KA-69A camera.

OTHER CAMERAS

The aerial cameras covered in this chapter comprise only a representative sampling. Illustrations and descriptions of the many types of aerial cameras currently in use by the U.S. Navy can be found in chapter 20 of the PH 3 and 2 Rate Training Manual, NavPers 10355-A, and in Airborne Photographic Equipment Supplement No. 1, RC 076475, published by the U.S. Air Force Systems Command's Reconnaissance Division Avionics Laboratory.

SQUADRON PHOTOGRAPHER'S RESPONSIBILITY FOR CAMERA INSTALLATION

It is the duty of the photographers mate(s) assigned to an aircraft squadron to install/remove the photographic control systems, camera

Table 8-7.—KA-74A camera characteristics.

Type	Day/night low altitude surveillance framing camera.
Format size	4.5 x 4.5 inches.
Film capacity	5 inches by 100 ft – standard base (5.2mm). 5 inches by 180 ft – thin base (2.5mm).
Lens	6 inch focal length f/2.8 coated with antireflection coating.
Angular coverage	41 degrees, 6 minutes.
Exposure control	Remote.
Shutter type	Focal plane day/night, bidirectional.
Shutter speeds	1/1000, 1/2000 and night.
Shutter speed control	Remote.
Cycling rate	
Day HI	Autocycle 4 frames per second and manual.
Day LO	Autocycle 1 frame per second and manual.
Night	Autocycle 1 frame per second and manual.
Alternate	2 frames per second in lieu of 1 frame per second with gear change.
Film flattening	Vacuum platen.
Forward motion picture Compensation (fmc)	Zonal (moving film).
Camera power requirement	115 volts, a.c., 400 hertz, 3 phase, 1.7 amperes peak 28 volts, d.c., 1.4 amperes peak, 150 watts average total.
Thermal control	Internal heaters and thermostats, to insure reliable operation to -65° F.
Heater power	115 volts, a.c., 400 hertz, single phase, 5 amperes peak.
Camera weight (with film)	37 pounds.
Camera width	8 1/2 inches.
Camera length	12 inches.
Camera height	14 1/2 inches.

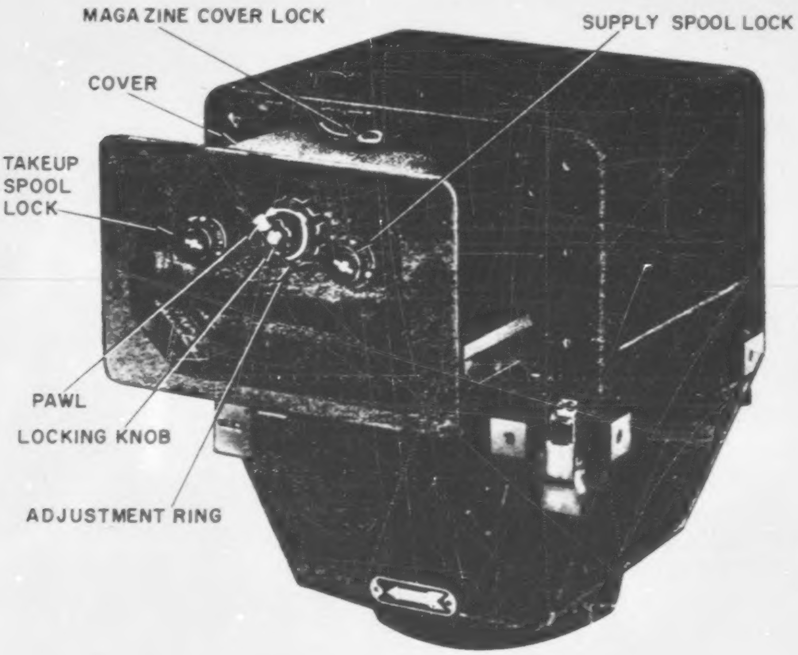
Table 8-8.—Exposure selections.

Exposure	Day		Night
	Shutter Speed		
	1/1000	1/2000	
Dull	f/2.8	f/2.8	f/2.8
Hazy	f/5.6	f/4	f/2.8
Bright	f/8	f/5.6	f/2.8

mounts, and cameras on his respective squadron's aircraft. He also performs all preventive and organizational maintenance on the photographic control system, mounts, and cameras and insures that they are maintained in a proper working condition. He will insure that sufficient repair parts for the system, mounts, and cameras are on hand and that adequate photographic supplies, film, etc. are available to enable the squadron to carry out their photographic assignments.

The squadron photographer will load and unload his respective squadron's film magazines and insure that after the film has been exposed it is properly processed and all photographic work requests are accomplished. Squadron photographers will normally undertake all photographic work requests and assignments of their squadrons, exclusive of that which must be accomplished directly in the ship or station photographic laboratory.

Squadron photographers are specially trained in the aerial cameras, camera control systems, camera mounts, installations, and related photographic equipment of their respective squadrons. They should not be assigned to the ship's or station's photographic laboratory except in emergency situations, and then only when such assignment will not adversely affect the squadron's photographic capability. Refer to The U.S. Navy Manual of Navy Photography, OPNAV



PH.483

Figure 8-49.—KA-74A Magazine Removal.

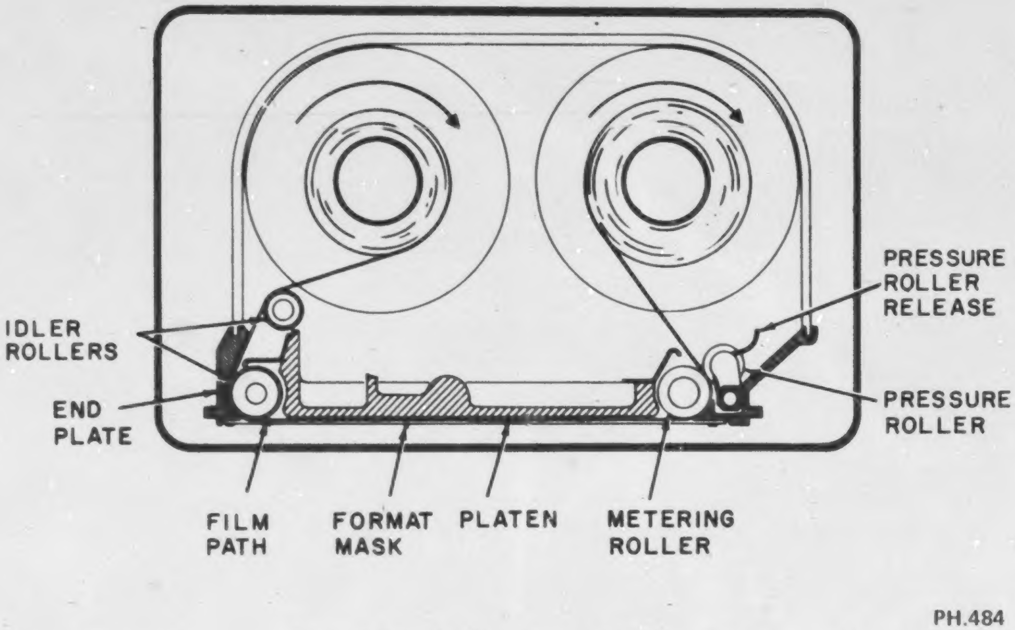

IDLER ROLLERS
END PLATE
FILM PATH
FORMAT MASK
PLATEN
METERING ROLLER
PRESSURE ROLLER RELEASE
PRESSURE ROLLER
PH.484

Figure 8-50.—KA-74A, film loading diagram.

3150.6 (Series) for additional information regarding the assignment of squadron photographers to augment the ship or station photographic lab. Squadrons doing only a limited amount of photography, but which have photographers assigned, will often assign them to the ship or station photo lab. If the squadron photographer(s) are assigned to augment the supporting activity's photographic lab, then all of the previously mentioned photographic responsibilities are assumed by that ship or station photographic laboratory. Only close cooperation and teamwork between the squadron photographer(s) and ship or stations photographers can insure the satisfactory accomplishment of the Navy's photographic missions.

CHAPTER 9

ACCESSORIES FOR AERIAL PHOTOGRAPHY

There are various types of accessories which are necessary for the successful completion of the aerial photographic mission.

In modern photographic aircraft, which are capable of very high speeds and also performing low-altitude, high-speed photography, the standard aerial camera is not able to "stop" the motion resulting from the aircraft moving rapidly across the terrain. By moving the film in synchronization with the ground movement, this image movement (caused by forward aircraft motion) is eliminated. One method of eliminating this is through the use of an image motion compensating (IMC) magazine.

Aerial camera mounts must be capable of supporting one or more aerial cameras in an aircraft under all flight conditions. The mount must keep the camera in a steady position so that, at any instant, aerial photographs of the best possible quality can be taken of the desired objective. Three types of camera mounts are used in modern high-performance aircraft—fixed, rotatable, and gyrostabilized.

When high-performance aircraft came into use, the emphasis on maintaining the flight line and determining crab shifted from the aerial photographer to the pilot or the radar air navigator. Advanced aircraft design has greatly limited the pilot's and especially the observer's forward and downward field of view. This is due to the aircraft configuration and the installation of a great amount of specialized equipment. When it was found impossible to fly mapping and reconnaissance photographic missions without referring to the target terrain, new viewfinders had to be developed for both the pilot and observer. The new photo-viewfinders give the viewer a presentation of the terrain both in front and directly below the aircraft. All viewfinders are operated in approximately the same manner.

IMAGE MOTION COMPENSATION MAGAZINE

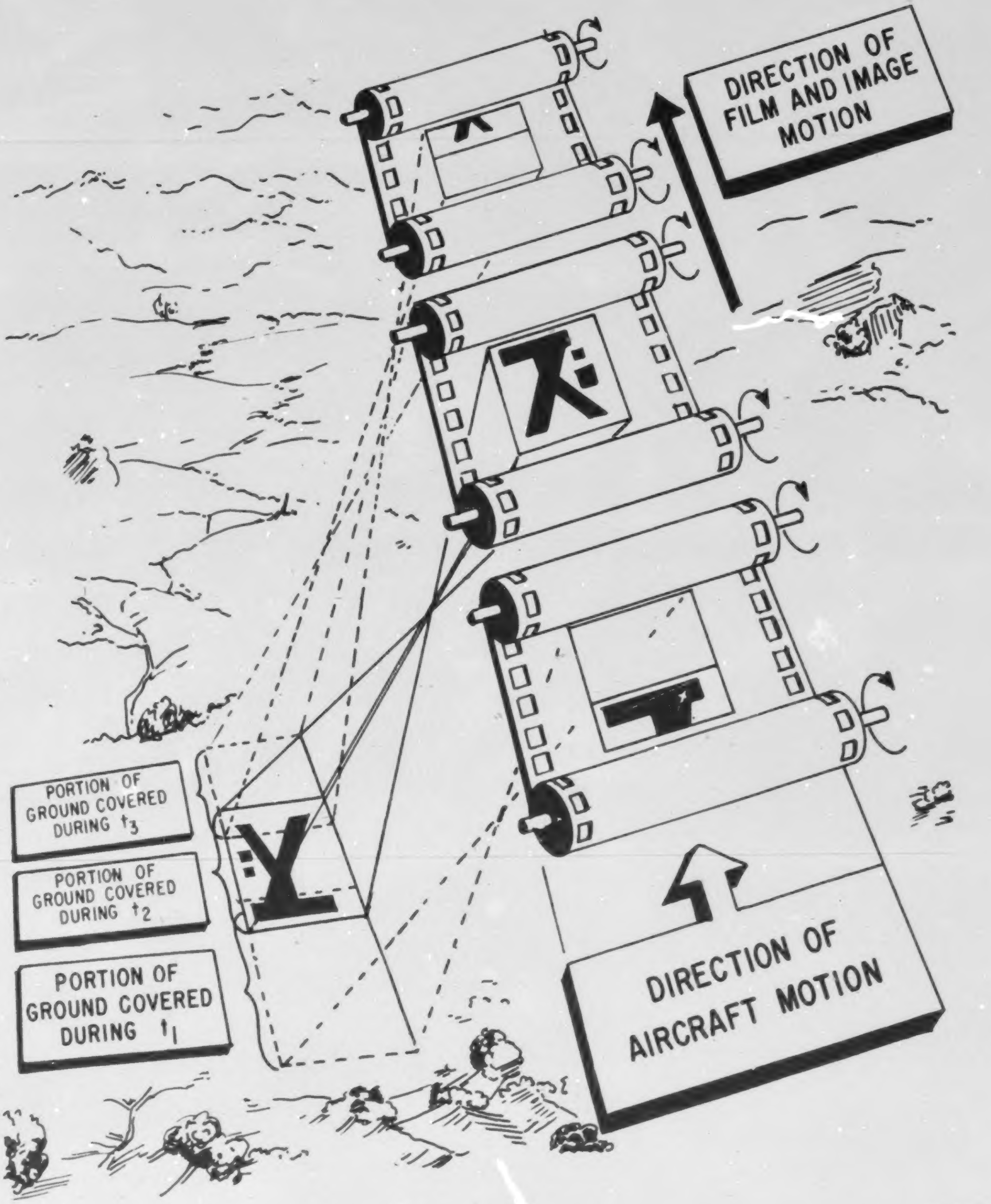
There are two general types of aerial camera film magazines. One is called a stationary film magazine because the film is held stationary during exposure. The other is called an image motion compensating (IMC) magazine because the film is moved during exposure to correct for the image motion caused by aircraft travel across the object being photographed.

The principle of image motion compensation can best be understood by studying figure 9-1.

The flight direction of the aircraft is shown, and the relative motion of the ground (with respect to the aircraft) is in the opposite direction. However, since the lens inverts the image of an object, the motion of the image on the focal plane of the camera is in the same direction as that of the aircraft. Therefore, during any interval in which the shutter is open and the film is transported in the same direction as the aircraft (and image motion) at the same speed as that of the image, there is no motion of the image with respect to the film.

As shown in figure 9-1, at time t_1, the image of the aircraft on the field strikes the film at point X. At time t_2, the image of the aircraft is now near the forward part of the platen. However, since the film has moved during the interval, the image is still at point X, and there has been no motion of the image with respect to the film.

To accomplish the proper movement of the film during exposure, an IMC magazine is used. In this magazine the film moves very rapidly during the takeup portion of the cycle, and then slows down to the same speed as that of the image in order to take the next exposure. At that instant, the shutter is energized to make an


DIRECTION OF FILM AND IMAGE MOTION
PORTION OF GROUND COVERED DURING t_3
PORTION OF GROUND COVERED DURING t_2
PORTION OF GROUND COVERED DURING t_1
DIRECTION OF AIRCRAFT MOTION

PH.485

Figure 9-1.—Principle of image motion compensation.

instantaneous exposure, after which the exposed film is again taken up at a much greater rate of speed. This cycle is repeated to provide a series of individual exposures. On low-altitude high-speed photographic missions, where individual exposures are required, the IMC magazine must be used with an appropriate camera. Some cameras and mounts in present use have IMC features incorporated in them.

CAMERA MOUNTS

In the RA-5C aircraft there are four electronically controlled camera mounts. The LA-215A azimuth-controlled camera mount is installed in sensor station 2. All other electronically controlled camera mounts are located in sensor station 4, depending on which module is installed (mount LA-216A in module No. 3, mount LA-297A in module No. 1 or No. 2, and mount LA-301A in module No. 2).

NOTE: The RA-5C station 2 was originally designed with a LA-215A mount with KA-50A camera installed in the mount. With and only with this original configuration can the LA-215A control azimuth. Airframe change 180 allows the KA-51A camera to be installed in the LA-215A mount in station 2 but due to space limitations, control of azimuth cannot be accomplished without damage to the KA-51 camera.

MODEL LA-215A MOUNT

The model LA-215A (azimuth-controlled) camera mount (fig. 9-2) is installed in sensor station 2 located in the RA-5C lower fuselage fairing as shown in figure 9-3. The mount is canted 4 degrees forward along the Y-axis of the aircraft, causing the optical axis of the camera to be perpendicular to the ground when the aircraft is flying in its normal 4-degree noseup attitude.

The azimuth-controlled mount is an electromechanical device constructed of cast aluminum and requires both a-c and d-c power for operation. Its functions are as follows:

1. To provide a mount for the still picture camera (KA-51).
2. To maintain the optical axis of the camera in a fixed position (perpendicular to the ground).
3. To provide corrective positioning of the camera to compensate for drift of the aircraft.

The capabilities and limitations of the mount are given in table 9-1.

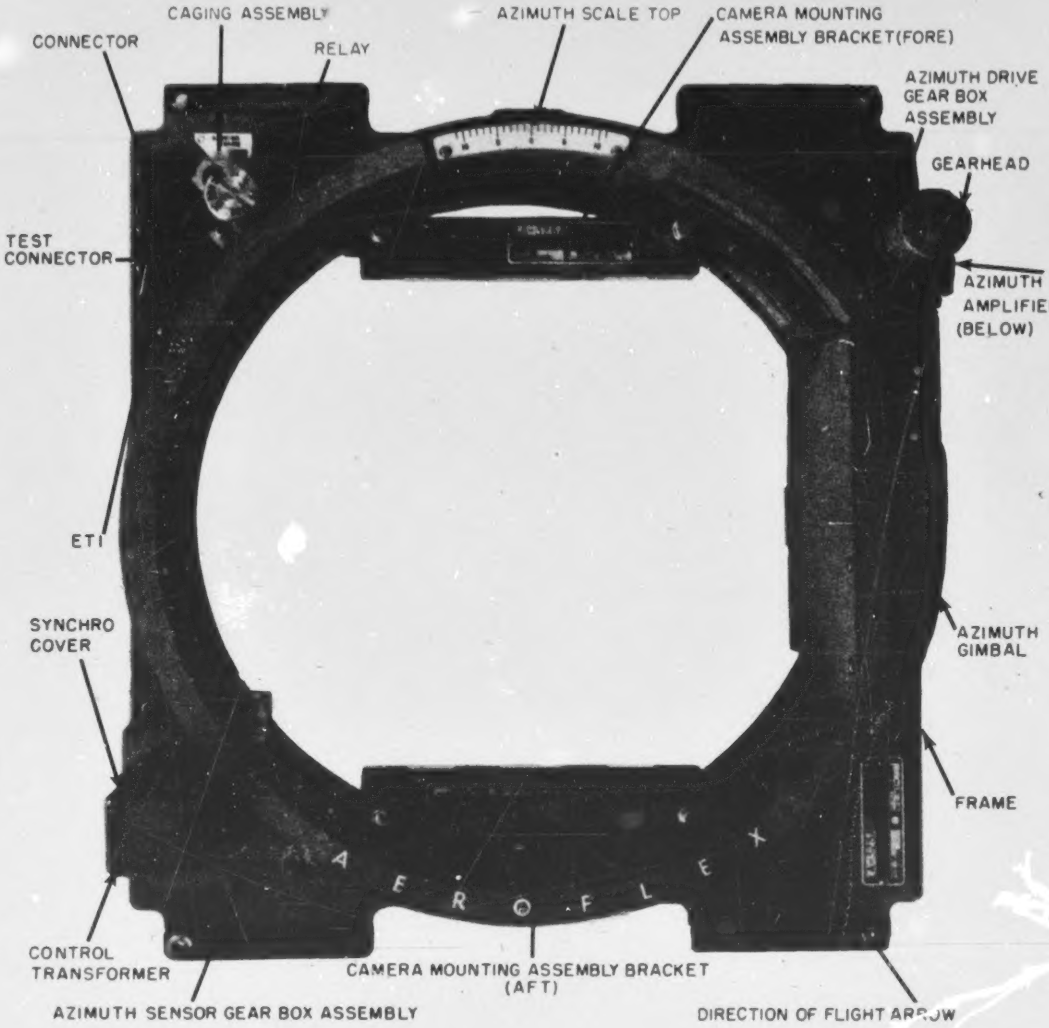
Operation

Control and operation of the azimuth-controlled mount are accomplished through a combination of electrical and mechanical devices.

The camera is held in the mount by two camera mounting brackets (one fore and one aft) which are fastened to the AZIMUTH GIMBAL (fig. 9-2). The azimuth gimbal is cylindrical in shape and rides on two ball bearings located on the upper and lower edges of the main frame of the mount. It is driven by a gear train located on the frame which meshes with a sector gear on the gimbal. The position of the gimbal is determined by a SYNCHRO TRANSFORMER which is driven by another section gear on the gimbal. (See fig. 9-2.)

Complete control of the mount assembly is provided by the POWER switch on the photonavigator's control panel. The mount assembly positions the camera in the azimuth axis to correct for azimuth drift. Signals for this correction are supplied by either the data converter (CV-1408/AYA-1) or the optical viewfinder, depending on the position of the POWER switch on the viewfinder. If there is a failure in the mount, the camera readiness indicator reads OFF.

AZIMUTH SENSOR GEARBOX ASSEMBLY.–This assembly consists of an azimuth synchro control transformer and multiplying gears. The ROTOR of the azimuth control transformer is connected to the azimuth gimbal. The synchro control transformer receives its signals from the data converter through the stator, and the control transformer rotor transmits its signal to the azimuth amplifier. The function of the azimuth synchro control transformer is to receive "drift" signals from the data converter and a mechanical "feedback" signal through the rotor of the control transformer. The variation in these two signals appears at the rotor as an error signal and is applied to the azimuth amplifier which follows it. (See fig. 9-2.)


CAGING ASSEMBLY
AZIMUTH SCALE TOP
CAMERA MOUNTING ASSEMBLY BRACKET(FORE)
CONNECTOR
RELAY
AZIMUTH DRIVE GEAR BOX ASSEMBLY
GEARHEAD
TEST CONNECTOR
AZIMUTH AMPLIFIER (BELOW)
ETI
SYNCHRO COVER
AZIMUTH GIMBAL
FRAME
AEROFLEX
CONTROL TRANSFORMER
CAMERA MOUNTING ASSEMBLY BRACKET (AFT)
AZIMUTH SENSOR GEAR BOX ASSEMBLY
DIRECTION OF FLIGHT ARROW

PH.486

Figure 9-2.—Aircraft camera mount, model LA-215A.

AZIMUTH DRIVE GEARBOX ASSEMBLY.–This assembly consists of a gearhead motor, azimuth amplifier, and multiplying gears. The signal received by the amplifier from the rotor of the control transformer is amplified, phase-shifted, and conducted to the gearhead motor. The gearhead motor then drives the azimuth gimbal to the desired azimuth angle. A mechanical feedback exists between the gearhead motor, gimbal, and synchro; and as the gimbal is driven to the required position by the input data (signal), the synchro rotor is driven towards a voltage null point. When the null point is reached, the azimuth gimbal assumes its steady-state position.

Additional and more complete details on this mount, and all other aerial camera mounts used in the RA-5C aircraft, can be obtained by referring to NavAir 01-60ABC-2-10, NavAir 01-60ABC-2-10.1, and NavAir 01-60ABC-2-10.1.1,

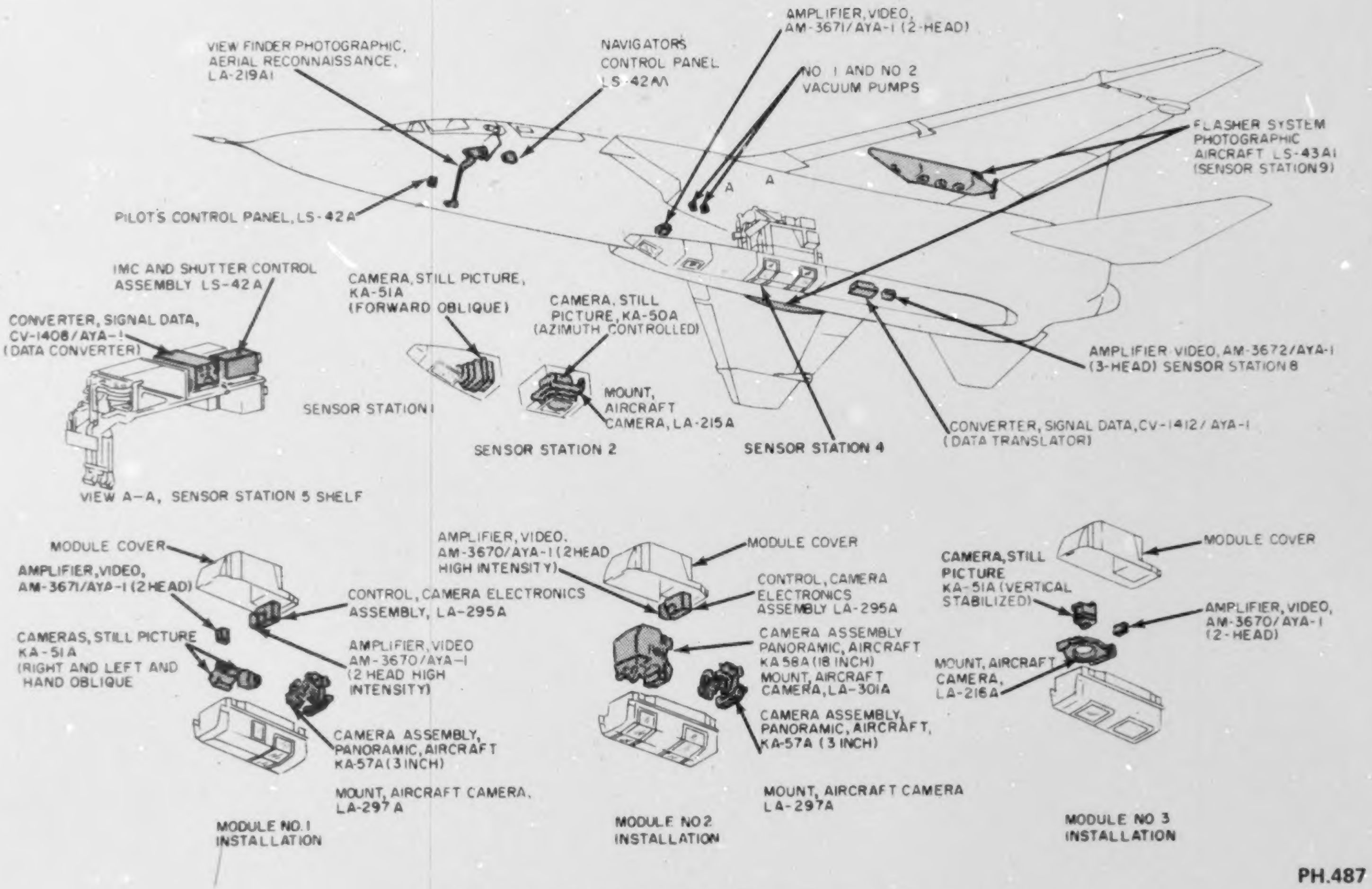

VIEW FINDER PHOTOGRAPHIC, AERIAL RECONNAISSANCE, LA-219A1
NAVIGATORS CONTROL PANEL LS-42AA
AMPLIFIER, VIDEO, AM-3671/AYA-1 (2-HEAD)
NO 1 AND NO 2 VACUUM PUMPS
FLASHER SYSTEM PHOTOGRAPHIC AIRCRAFT LS-43A1 (SENSOR STATION 9)
A
A
PILOT'S CONTROL PANEL, LS-42A
IMC AND SHUTTER CONTROL ASSEMBLY LS-42A
CONVERTER, SIGNAL DATA, CV-1408/AYA-1 (DATA CONVERTER)
CAMERA, STILL PICTURE, KA-51A (FORWARD OBLIQUE)
CAMERA, STILL PICTURE, KA-50A (AZIMUTH CONTROLLED)
MOUNT, AIRCRAFT CAMERA, LA-215A
SENSOR STATION 1
SENSOR STATION 2
SENSOR STATION 4
AMPLIFIER VIDEO, AM-3672/AYA-1 (3-HEAD) SENSOR STATION 8
CONVERTER, SIGNAL DATA, CV-1412/AYA-1 (DATA TRANSLATOR)
VIEW A—A, SENSOR STATION 5 SHELF
MODULE COVER
AMPLIFIER, VIDEO, AM-3671/AYA-1 (2 HEAD)
CAMERAS, STILL PICTURE KA-51A (RIGHT AND LEFT AND HAND OBLIQUE)
CONTROL, CAMERA ELECTRONICS ASSEMBLY, LA-295A
AMPLIFIER, VIDEO AM-3670/AYA-1 (2 HEAD HIGH INTENSITY)
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT KA-57A (3 INCH)
MOUNT, AIRCRAFT CAMERA, LA-297A
MODULE NO. 1 INSTALLATION
AMPLIFIER, VIDEO, AM-3670/AYA-1 (2HEAD HIGH INTENSITY)
MODULE COVER
CONTROL, CAMERA ELECTRONICS ASSEMBLY LA-295A
CAMERA ASSEMBLY PANORAMIC, AIRCRAFT KA 58A (18 INCH)
MOUNT, AIRCRAFT CAMERA, LA-301A
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KA-57A (3 INCH)
MOUNT, AIRCRAFT CAMERA LA-297A
MODULE NO 2 INSTALLATION
CAMERA, STILL PICTURE KA-51A (VERTICAL STABILIZED)
MODULE COVER
AMPLIFIER, VIDEO, AM-3670/AYA-1 (2-HEAD)
MOUNT, AIRCRAFT CAMERA, LA-216A
MODULE NO 3 INSTALLATION
PH.487

Figure 9-3.—Aerial photographic equipment locator diagram.

Table 9-1.—Capabilities and limitations of the model LA-215A mount.

Gimbal freedom of rotation.	Clockwise 10 (±0. 5) degrees. Counterclockwise 10 (±0. 5) degrees.
Servo loop static positioning accuracy.	0. 5 degree.
Step input followup rate.	10 degrees clockwise to 10 degrees counterclockwise within 20 seconds.

NOTE.—The IMC function in the RA-5C photographic system is an internal function within the cameras themselves and not a function of the mounts.

Maintenance Instructions Manuals for the RA-5C Aerial Photographic Systems.

MODEL LA-216A MOUNT

The vertical stabilized still picture camera mount assembly (fig. 9-4.), located in module No. 3, sensor station 4, contains a camera mounting platform which is mechanically coup[illegible]o the mount frame thorugh the azimuth, pitch, and roll gimbals. The mount is inertially stabilized by the aircraft reference system against pitch and roll angular motions of the aircraft and is corrected for drift by the data converter or the optical viewfinder. The control chassis assembly is also associated with the vertical stabilized camera mount assembly, and is located on the equipment support shelf of the No. 3 module. (See fig. 9-5.)

Operation

In operation the LA-216A mount is very much like the ART-17 (188) camera mount used in the RA-3B aircraft, except that the latter does not have the ability to transmit signals to the data recorder in the camera. Because of the similarity of operation of the two mounts, a complete description of the LA-216A operation will not be given. However, the capabilities and limitations will be given for comparative purposes and are listed in table 9-2.

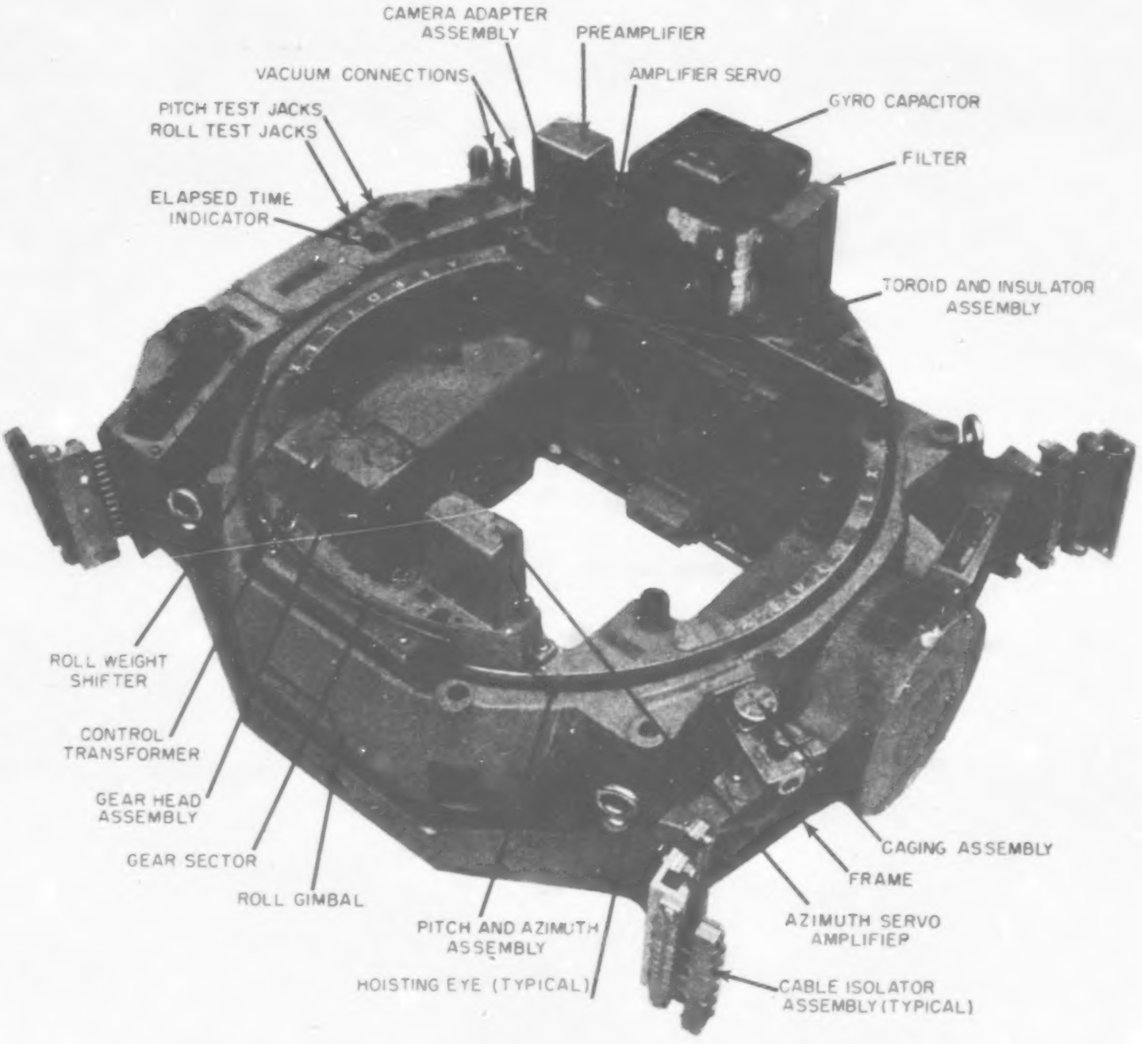
Table 9-2.—Capabilities and limitations of the model LA-216A mount.

Azimuth correction range	± 10 degrees.
Pitch correction range	± 5 degrees.
Roll correction range	± 5 degrees.
Azimuth correction accuracy	± 0. 5 degrees.
Pitch correction accuracy	± 17 minutes of an arc.
Roll correction accuracy	± 17 minutes of an arc.
Azimuth correction time	Less than 20 seconds for full 20 degrees traveled.
Weight shifter capability	20 pounds per inch.
Pitch correction time	Instantaneous up to ± 5 degrees.
Mount erection time	2 minutes.
Roll correction time	Instantaneous up to ± 5 degrees.
Mount recovery time	3. 5 seconds.

Complete descriptive information, component assemblies, and maintenance instructions for the LA-216A vertical stablized still picture camera mount can be found in Sections II and III, of NavAir 01-60ABC-2-10.1, Aerial Photographic Systems.

MODEL LA-297A MOUNT

The model LA-297A aerial camera mount is made specifically for the KA-57A, 3-inch panoramic camera. It is a part of the pan-camera stabilization subsystem which consists of two


CAMERA ADAPTER ASSEMBLY
PREAMPLIFIER
VACUUM CONNECTIONS
AMPLIFIER SERVO
PITCH TEST JACKS
ROLL TEST JACKS
GYRO CAPACITOR
FILTER
ELAPSED TIME INDICATOR
TOROID AND INSULATOR ASSEMBLY
ROLL WEIGHT SHIFTER
CONTROL TRANSFORMER
GEAR HEAD ASSEMBLY
GEAR SECTOR
ROLL GIMBAL
CAGING ASSEMBLY
FRAME
AZIMUTH SERVO AMPLIFIER
PITCH AND AZIMUTH ASSEMBLY
HOISTING EYE (TYPICAL)
CABLE ISOLATOR ASSEMBLY (TYPICAL)

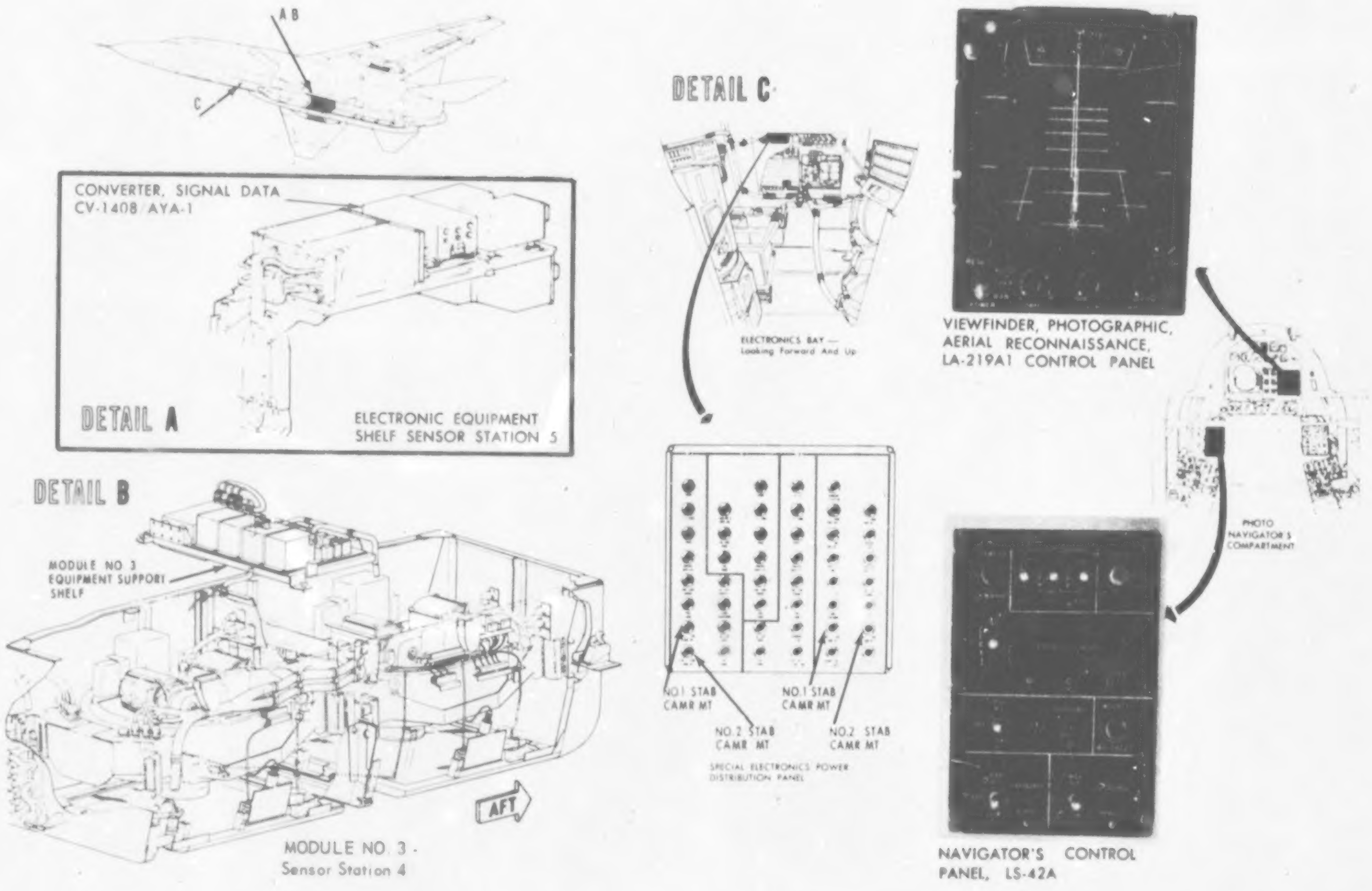
PH.488

Figure 9-4.—Aircraft camera mount, model LA-216A.

separate assemblies: the MOUNT assembly and the MOUNT ELECTRONICS assembly (fig. 9-6). The mount gimbal structure is of the inside-out type (Hooke's joint), in which the stabilized platform is external to the gimbals rather than internal. The azimuth gimbal is the stabilized platform on which the camera is mounted, and contains both the vertical gyro and the directional gyro. Roll and pitch are sensed and controlled by the vertical gyro and azimuth stabilization is sensed and maintained by the directional gyro.

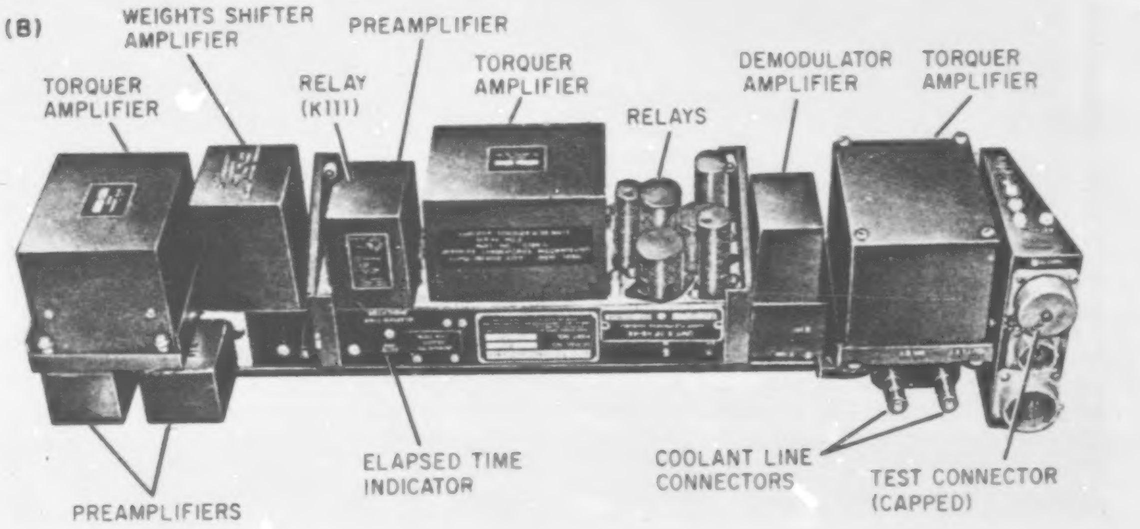
The frame and gimbals are machined, aluminum-magnesium alloy castings. For lifting purposes there are two lifting eyes, one at the top of each frame, to accommodate the installation or removal of the camera mount. (See fig. 9-7.)

Cable type vibration and shock isolators on the LA-297A mount (fig. 9-7) are similar to those used on other mounts installed in the


A B
C
DETAIL A
CONVERTER, SIGNAL DATA
CV-1408/AYA-1
ELECTRONIC EQUIPMENT
SHELF SENSOR STATION 5
DETAIL B
MODULE NO. 3
EQUIPMENT SUPPORT
SHELF
AFT
MODULE NO. 3 -
Sensor Station 4
DETAIL C
ELECTRONICS BAY —
Looking Forward And Up
NO.1 STAB
CAMR MT
NO.2 STAB
CAMR MT
NO.1 STAB
CAMR MT
NO.2 STAB
CAMR MT
SPECIAL ELECTRONICS POWER
DISTRIBUTION PANEL
VIEWFINDER, PHOTOGRAPHIC,
AERIAL RECONNAISSANCE,
LA-219A1 CONTROL PANEL
PHOTO
NAVIGATOR'S
COMPARTMENT
NAVIGATOR'S CONTROL
PANEL, LS-42A

PH.489

Figure 9-5.—Vertical stabilized still picture camera mount system component location.


(B)
WEIGHTS SHIFTER AMPLIFIER
PREAMPLIFIER
TORQUER AMPLIFIER
RELAY (K111)
TORQUER AMPLIFIER
RELAYS
DEMODULATOR AMPLIFIER
TORQUER AMPLIFIER
ELAPSED TIME INDICATOR
COOLANT LINE CONNECTORS
TEST CONNECTOR (CAPPED)
PREAMPLIFIERS

PH.490

Figure 9-6.—LA-297A mount, electronic components.

RA-5C aircraft. On the LA-297A mount these vibration isolators are used to isolate the camera assembly from the influence of aircraft vibrations, acceleration, and shock. These isolators are closely alined and referenced to the camera mounting surface on the stabilized platform.

Inlet and outlet liquid coolant line connectors on top of the starboard frame provide for connection of coolant lines to the mount assembly. Flexible lines connect the frame coolant lines to the gimbals. (See fig. 9-8.)

All mount electrical connectors are on top of the port frame. (See fig. 9-8.) Additional information on the LA-297A mount can be found in NavAir 01-60ABC-2-10.1 and NavAir 01-60ABC-2-10.1.1, RA-5C Aircraft, Aerial Photographic Systems.

NOTE: A-5 Photographic Change No. 37 and Airframe Change No. 297 remove the vertical gyro from RA-5C mounts.

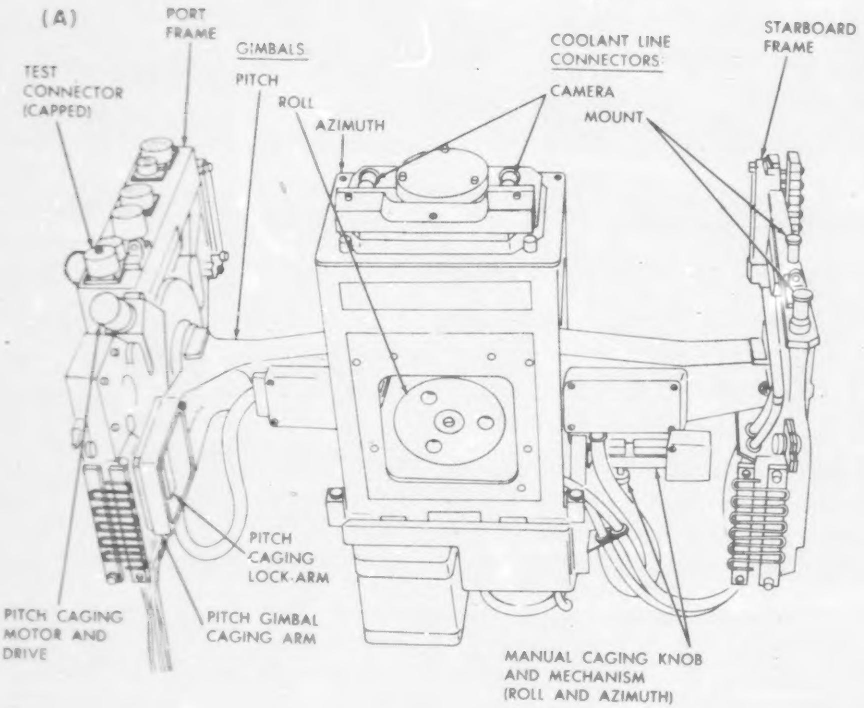
MODEL LA-301A MOUNT

The mount assembly (like the LA-297A mount) consists of the mount, mount electronics, and various other components as shown in figure 9-9.

The electronics assembly is attached to a cantilever platform which forms the rear section of the azimuth gimbal. A part of this electronics assembly is the AZIMUTH DIRECTIONAL GYRO. The electronics assembly is made up of an upper and lower chassis attached together with screw fasteners and is electrically connected through a pygmy connector. The mount assembly attaches to the module (No. 2) by cable type vibration and shock isolators which in turn attach to the fore and aft ends of each frame. These isolators, like those on the LA-297A mount, serve to insulate the camera from vibration, acceleration, and shock. The inlet and outlet coolant line connectors are located on the left-hand frame for connecting to the liquid cooling system. Flexible coolant lines connect the mount coolant lines to the gimbals. (See fig. 9-9.)

Mount Electronics

Except for the TORQUER AMPLIFIER (which is physically larger and has twice the power output capability), the mount electronics assembly is identical to the mount electronics


(A)
PORT FRAME
GIMBALS:
PITCH
ROLL
AZIMUTH
TEST CONNECTOR (CAPPED)
COOLANT LINE CONNECTORS:
CAMERA
MOUNT
STARBOARD FRAME
PITCH CAGING LOCK-ARM
PITCH CAGING MOTOR AND DRIVE
PITCH GIMBAL CAGING ARM
MANUAL CAGING KNOB AND MECHANISM (ROLL AND AZIMUTH)

PH.491

Figure 9-7.—LA-297A camera mount, 3-inch panoramic camera.

used on the model LA-297A (3-inch panoramic camera) mount assembly.

The mount electronics assembly contains all the stabilization system electronics except the ROLL and PITCH AMPLIFIERS (subassemblies of the vertical gyro). (See fig. 9-9.)

Weight Shifter Assembly

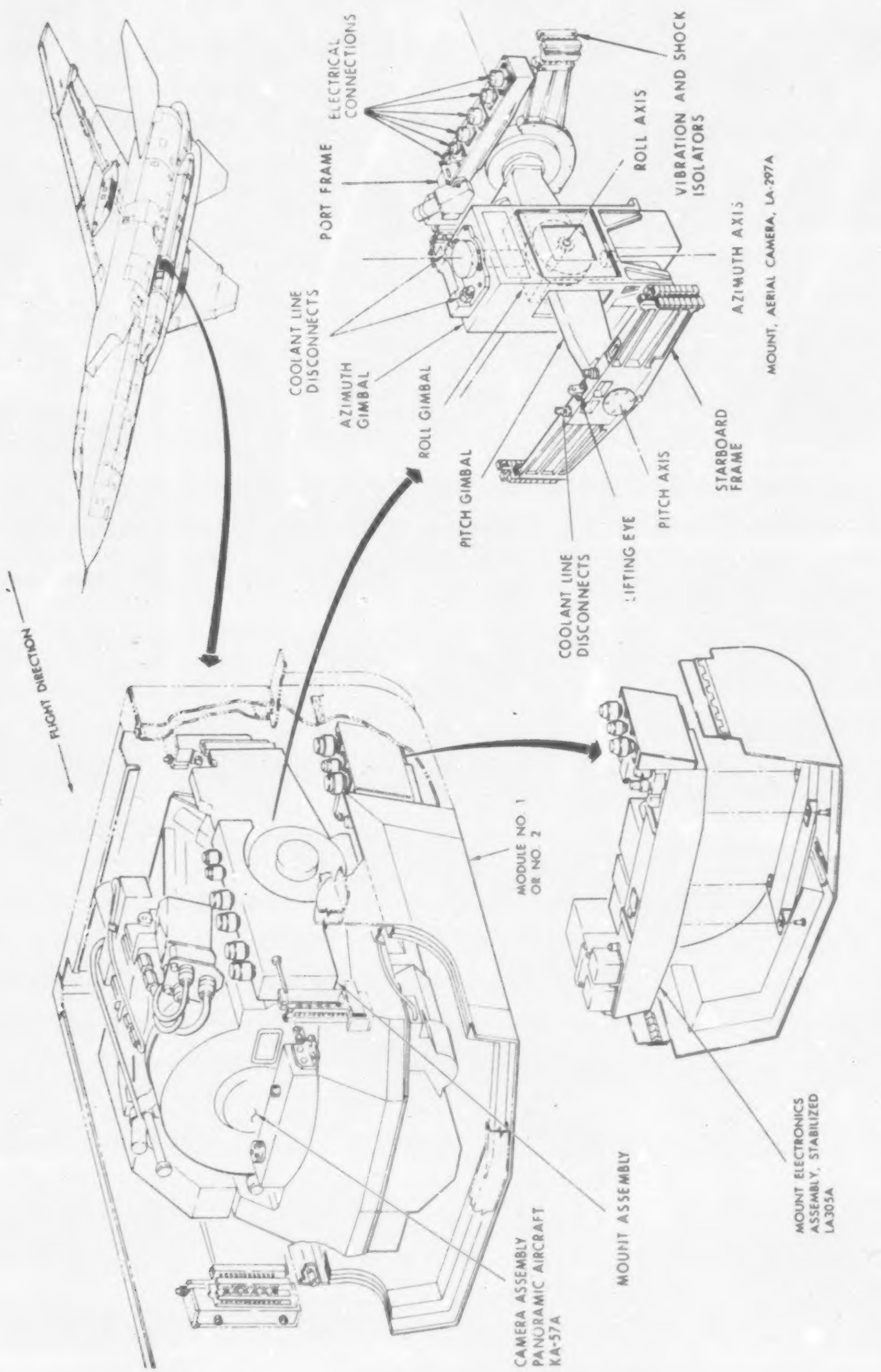
Attached to the bottom of the mount assembly is the weight shifter assembly. (See fig. 9-9.) It consists of movable weights, weight shifter, and weight shifter control system. The control system compensates for the center-of-gravity change when film is transferred from the supply magazine to the takeup magazine.

Additional information can be obtained by referring to the Maintenance Instructions Manual, NavAir 01-60ABC-2-10.1.1, Camera Systems, Panoramic, KA-68A and KA-69A.

PHOTO AIRCRAFT VIEWFINDERS

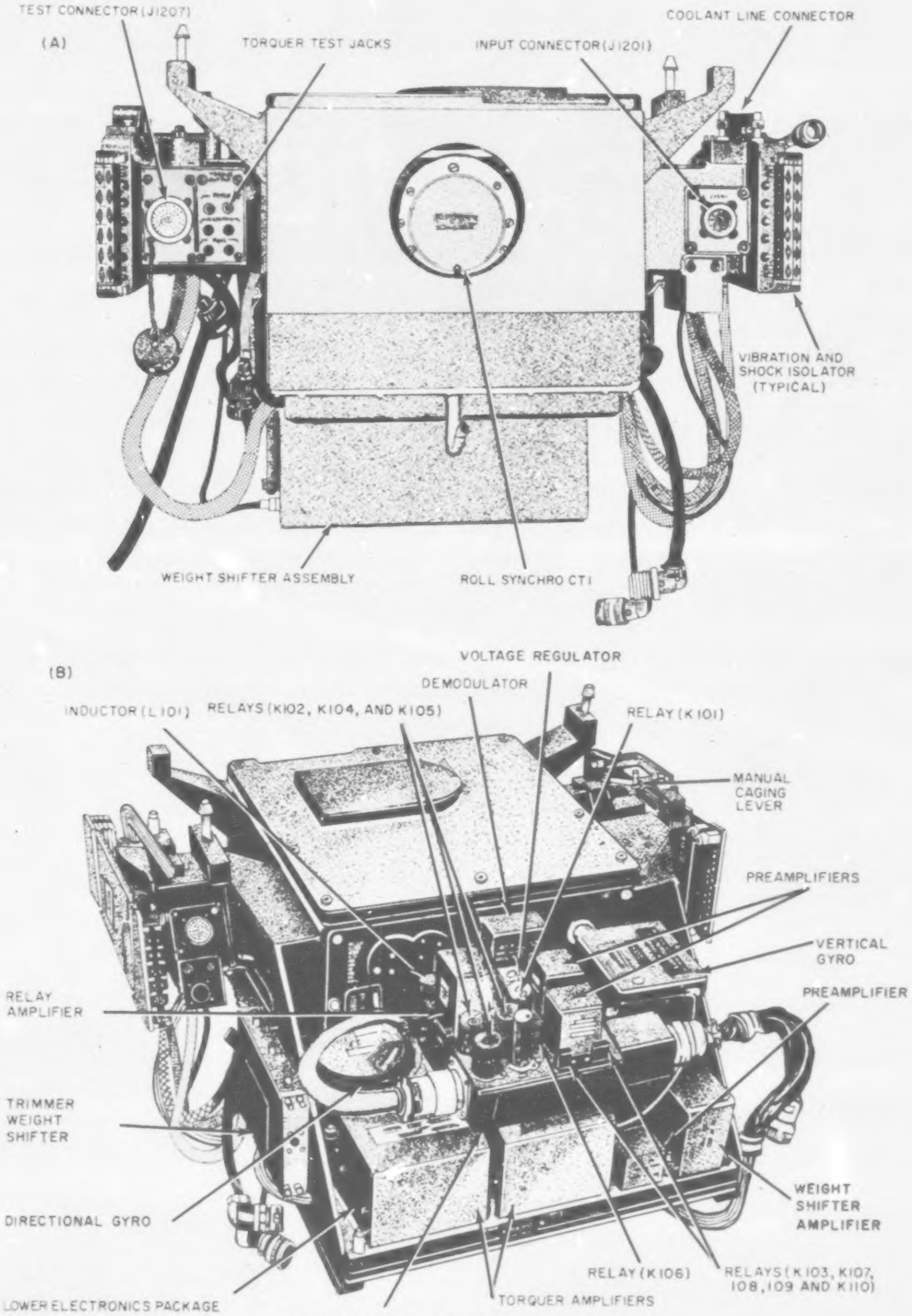
In order to control the operation of the cameras, the pilots and radar air navigators of photo-configured aircraft are provided with both camera controls and some means of sighting the target to be photographed. For forward firing cameras, the problem is reduced to pointing the nose of the aircraft at the object to be photographed.

For vertical photography, an optical sight is provided. The sight used at present in vertical photography is designed to reduce the pilot's problems to a minimum. This sight contains marks that can be used to ascertain drift, and marks that indicate the format covered by the more common cameras. In addition, intercept lines are provided for calculating the proper interval for obtaining 60 percent overlap in the direction of flight.


FLIGHT DIRECTION
ELECTRICAL CONNECTIONS
PORT FRAME
COOLANT LINE DISCONNECTS
AZIMUTH GIMBAL
ROLL GIMBAL
PITCH GIMBAL
COOLANT LINE DISCONNECTS
LIFTING EYE
PITCH AXIS
STARBOARD FRAME
AZIMUTH AXIS
ROLL AXIS
VIBRATION AND SHOCK ISOLATORS
MOUNT, AERIAL CAMERA, LA-297A
MODULE NO. 1 OR NO. 2
CAMERA ASSEMBLY PANORAMIC AIRCRAFT KA-57A
MOUNT ASSEMBLY
MOUNT ELECTRONICS ASSEMBLY, STABILIZED LA305A

PH.492

Figure 9-8.—LA-297A aerial camera mount and stabilization system unit locator.


(A)
TEST CONNECTOR (J1207)
TORQUER TEST JACKS
INPUT CONNECTOR (J1201)
COOLANT LINE CONNECTOR
VIBRATION AND SHOCK ISOLATOR (TYPICAL)
WEIGHT SHIFTER ASSEMBLY
ROLL SYNCHRO CT1
(B)
VOLTAGE REGULATOR
DEMODULATOR
INDUCTOR (L101)
RELAYS (K102, K104, AND K105)
RELAY (K101)
MANUAL CAGING LEVER
PREAMPLIFIERS
VERTICAL GYRO
PREAMPLIFIER
RELAY AMPLIFIER
TRIMMER WEIGHT SHIFTER
DIRECTIONAL GYRO
WEIGHT SHIFTER AMPLIFIER
RELAY (K106)
RELAYS (K103, K107, 108, 109 AND K110)
TORQUER AMPLIFIERS
LOWER ELECTRONICS PACKAGE
UPPER ELECTRONICS PACKAGE

PH.493

Figure 9-9.—Model LA-301A aerial camera mount 18-inch panoramic camera. (A) Front view. (B) Rear view.

For oblique photography, one method of ascertaining the angle of a target is to use marks on the leading edges of the wing. However, with sweptwing aircraft this is impossible. As a consequence, most aircraft are now provided with a separate oblique photography sight. This sight, which is similar to a ring gunsight, can be adjusted to various oblique angles. Since the sight is positioned near the pilot's shoulder when in use, the pilot can sight any oblique photography target by turning his head 90 degrees from the direction of flight.

All present day vertical photography viewfinders for photo-configured aircraft are of essentially the same design, their difference being in angle of view and controls.

LA-219A1 VIEWFINDER

In discussing the operation of a typical viewfinder the LA-219A1 photographic aerial reconnaissance viewfinder is given as an example.

The LA-219A1 viewfinder is an electronically controlled optical instrument that provides the radar air navigator with a clear unobstructed view of the terrain along the line of flight. It also provides him with a means to continuously monitor certain camera control signals and camera mount stabilization (drift) signals which are fed into the viewfinder from the data converter. The image view by the radar air navigator is direct and unreversed. Grid lines on the viewing screen give an approximation of the field of view of each camera.

The viewfinder is made up of two primary assemblies—the lower assembly and the upper assembly. The lower assembly is essentially a system of optical relays and a wide angle objective lens used to transmit optical images from an optically flat quartz window (mounted flush in the under side of the fuselage) to a viewing screen in the upper assembly. (See fig. 9-10.)

The upper assembly contains the viewing screen (with associated optical components), and viewfinder control panel, servomechanisms, and an electronics unit. Both the upper and lower assemblies are mounted with vibration isolators and are sealed and pressurized with dry nitrogen. As an aid to prevent fogging of the internal optics, replaceable desiccant cartridges with associated humidity indicators are installed in the viewfinder. To prevent fogging of the fuselage window, defrost air is continuously passed across it.

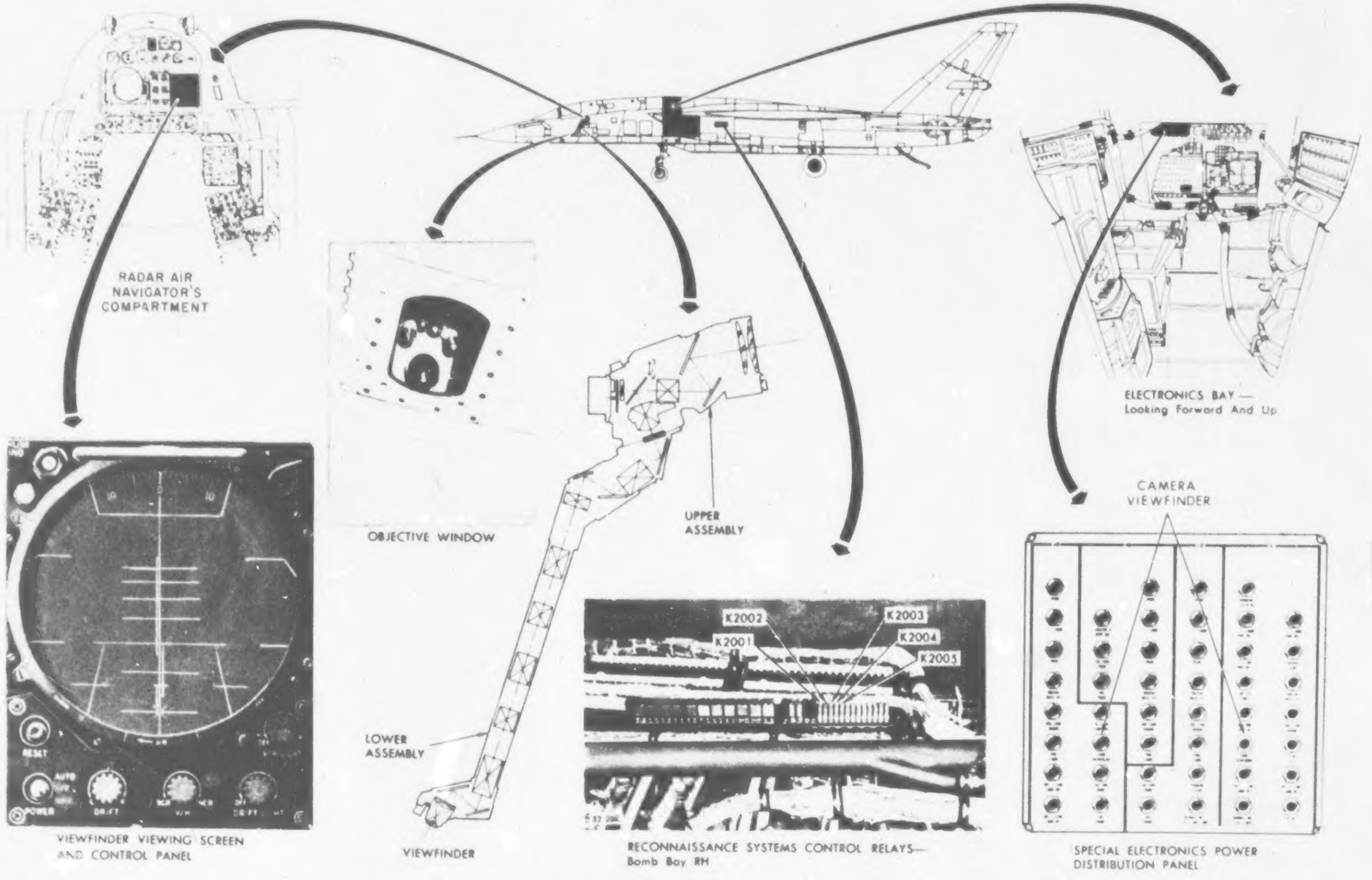
The field of view of the viewfinder is from 5 degrees aft of the nadir (nadir is a point directly below the aircraft) to 10 degrees below the aircraft horizontal forward, for a total of 85 degrees. The lateral field of view is also 85 degrees.

There are two reticles superimposed on the viewing screen of the viewfinder, one fixed and the other adjustable. The fixed reticle includes a drift angle pointer and coverage boundaries applicable to the forward oblique camera. The adjustable reticle is automatically or manually positioned to correspond to the aircraft flight path and includes a calibrated drift angle scale (±15 degrees), a fixed nadir point (perpendicular to the aircraft) and parallel center lines. This reticle also contains coverage boundaries applicable to the fully stabilized vertical still picture cameras and the panoramic cameras.

A traveling grid (Vg/H) is displayed on the reticles in a narrow corridor in the center of the viewing screen. It first appears on the screen at approximately 1 inch above the center and travels downward, disappearing at the nadir. This traveling grid allows the radar air navigator to check the accuracy of the Vg/H signals, received from the data converter, as they are applied to the cameras. Signals with errors can be replaced with correct signals through the use of controls on the viewfinder control panel. (See fig. 9-10.) This control panel is located directly below the viewing screen and contains the controls necessary for operation of the viewfinder.

The viewfinder can be operated in two modes—the automatic and the manual mode. Normal operation is in automatic. When errors appear in the automatic mode, the manual mode may be selected.

Automatic mode is selected by placing the POWER switch to the AUTO position. In this mode, signals are received from the data converter which positions the drift reticle and drives the Vg/H traveling grid. The drift signal is correct if the terrain reference points move across the viewing screen in a direction parallel to the drift reticle. The Vg/H signal is correct if the terrain reference points move down the viewing screen at the same rate as the Vg/H traveling


RADAR AIR NAVIGATOR'S COMPARTMENT
OBJECTIVE WINDOW
UPPER ASSEMBLY
LOWER ASSEMBLY
VIEWFINDER
ELECTRONICS BAY — Looking Forward And Up
CAMERA VIEWFINDER
K2001
K2002
K2003
K2004
K2005
VIEWFINDER VIEWING SCREEN AND CONTROL PANEL
RECONNAISSANCE SYSTEMS CONTROL RELAYS— Bomb Bay RH
SPECIAL ELECTRONICS POWER DISTRIBUTION PANEL
RESET
POWER
AUTO
DRIFT
V/H

PH.335

1. Junction box.
2. Wiring harness.
3. Aircraft cable connector J2.
4. LB-17A camera control.
5. Strongback (LB-31A).
6. Support lug.
7. Wedge type depression mount.
8. Connection to window heater R2
9. Forward heated window.
10. KB-19A 16mm motion picture strike camera.
11. Terminal board TB3.
12. Heater safety interlock switch S1.
13. KB-18B 70mm panoramic camera.
14. Door
15. Counterbalance cable pulley.
16. Door counterbalance cable.
17. Spring-loaded door counterbalance cable reel.

Figure 9-10.—Viewfinder component location.

grid. If these conditions are not met, the manual mode of operation should be used.

The manual mode is selected by placing the POWER switch to "MAN" position. Correction of the drift signal is achieved by moving the "DRIFT" synchro control until the drift reticle is parallel to the path of the terrain reference points. The Vg/H signal is corrected by moving the Vg/H synchro control until the Vg/H traveling grid lines move across the viewing screen at the same rate as the terrain reference points.

Maintenance of the LA-219A1 Viewfinder

Organizational level maintenance for the LA-219A1 viewfinder includes general cleaning procedures for optical surfaces, operational checks, and use of the E12301 flight line tester.

GENERAL CLEANING PROCEDURES FOR OPTICAL SURFACES.—All optical surfaces should be inspected for smudges, fingerprints, oil film, and dust particles. These surfaces should be cleaned only when excessively dirty since repeated cleaning is more harmful than helpful. The following procedure is used to clean windows or lenses which are dusty but not smudged with fingerprints, grease, oil, or other material:

1. Using only a clean lens brush, gently loosen the dirt from the optical surface. At the end of each brush stroke the excessive dirt should be removed from the brush by rapping it against a hard object.

2. Using the air syringe, blow any remaining dirt away from the glass surface.

3. Draw dislocated particles away from the glass by holding a vacuum cleaner nozzle (with soft rubber hose attachments) adjacent to the work.

The following procedure should be followed when cleaning smudges, fingerprints, or oil film from optical surfaces:

1. Using a vacuum cleaner and soft rubber attachment, remove loose dust particles from optical surface.

2. Moisten a pad of lens tissue with Orvis solution made from "WA" paste manufactured by Proctor and Gamble. The solution is mixed by using one-half teaspoon of "WA" paste to 1 gallon of distilled water.

3. The pad should be thoroughly moistened but not dripping wet. The following precautions must be taken:

a. Never apply cleaning solution directly to optical surfaces. Take care not to touch the area of lens tissue to be used for cleaning.

b. Care should be exercised not to have cleaning solution or foreign material lodge between the glass and sealing compound.

4. Clean the glass surface using a gentle straightline motion for windows and any rectangular surfaces, working outward from the center, and with a gentle circular motion starting at the center of the surface working outward for lens or circular surfaces.

CAUTION: Never use a scrubbing motion.

5. To insure cleanliness, change lens tissue frequently. Destroy all used lens tissue. Used lens tissue may become contaminated and scratch or mar optical surfaces.

6. Remove all traces of Orvis solution from the optical surface, using clean lens tissue moistened with acetone.

7. For persistent deposits which cannot be removed by the use of Orvis solution, substitute methyl alcohol for the Orvis solution and repeat steps 1 through 5.

8. When the surface is completely clean and dry, blow off any loose particles and dust with an air syringe; use a vacuum cleaner to collect the loose particles. A lens brush may be used to loosen particles.

The preceding cleaning techniques for optical surfaces should be followed whenever cleaning any of the following: Camera viewing windows; camera lens; viewfinder lens; objective windows; and flasher quartz windows.

LA-219A1 VIEWFINDER OPERATIONAL CHECK.—This viewfinder is operationally tested in two modes of operation: manual and automatic. These modes of operation are selected by the power switch located on the viewfinder control panel. An automatic check of the viewfinder in the automatic mode of operation may be performed either during flight or on the ground. During flight, the power switch is placed in the "auto" position. In the automatic (auto) mode, the operator monitors externally generated V/H and drift angle signals on the viewing screen. If the V/H signal is correct, the operator will observe that a terrain reference point (target) along the aircraft's flight path will move across the viewing screen at the same rate as the traveling grid lines. If the drift angle is correct, the operator will observe that a target along the flight path will move across the screen in a direction parallel with the drift angle indicator.

E12301 FLIGHT LINE TESTER. The E12301 flight line tester for the LA-219A1 viewfinder is only one of several types of test equipment used in Naval photography. Due to the ever increasing complexity, need for greater accuracy and dependability of aerial photographic equipment, and to save man-hours involved in the testing and maintenance of photographic equipment, the use of testing sets has increased over the past years.

Procedure for using the E12301 flight line tester is presented as a typical example of the various types of test sets. It is not within the scope of this rate training manual to cover in detail all the various test sets used in Naval photography. Detailed instructions regarding individual types of test sets can be found in their respective operating and maintenance manuals.

The following facilities and equipment are required for performing a ground check for automatic operation of the LA-219A1 viewfinder:

1. External electrical power source.
2. External cooling air source.
3. Flight Line Tester (Data Converter and Viewfinder) E12301.
4. Interphone Assembly E3980-101.
5. Power Transfer Adapter E7346.
6. Conditioned Air Dump Valve Assembly E7304.

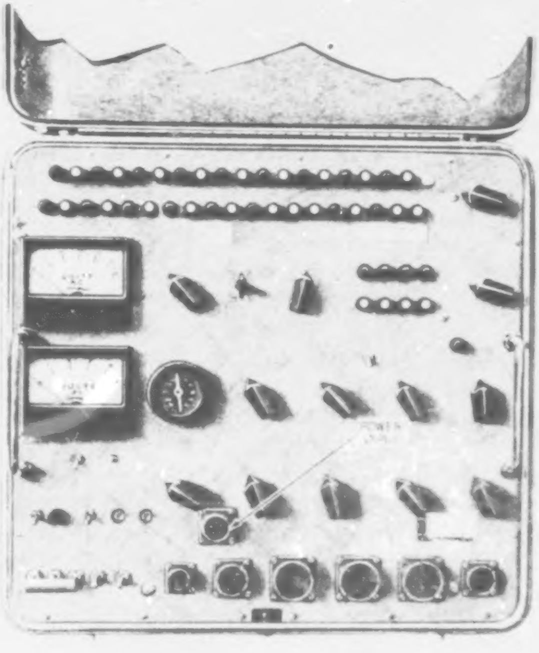
Two men are required to perform the following ground check procedure. Remove the camera module from sensor station No. 4 and lower the electronic equipment mounting shelf located in sensor station No. 5. Open the cover of the flight line test set E 12301 (fig. 9-11) and place all switches and circuit breakers located on the flight line tester in the "off" position.

Position the switches of the flight line tester E 12301 as described in the Maintenance Instruction Manual, NavAir 01-60ABC-2-10.1, for the RA-5C aircraft. Remove the cables from the cable case and connect as shown in figure 9-12. Complete the remaining steps of the test procedure as listed in NavAir 01-60ABC-2-10.1.

Complete details regarding maintenance, installation, and operation of the LA-219A1 viewfinder can be found in NavAir 01-60ABC-2-10.1, Maintenance Instructions Manual Navy Model RA-5C Aircraft, Aerial Photographic Systems Cameras, Still Picture, KA-50A and KA-51A and Related Systems.

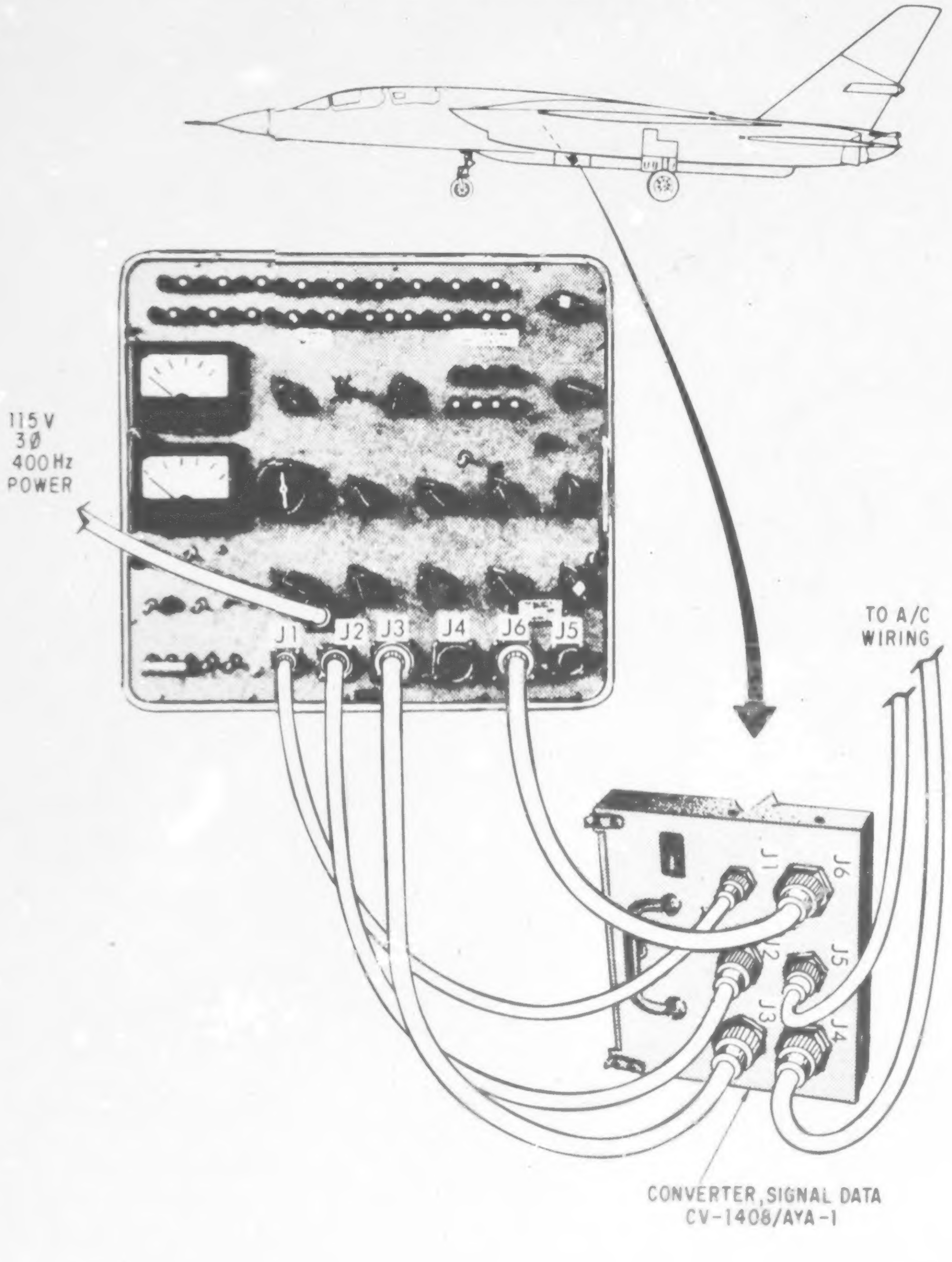
AIRCRAFT CAMERA POD ASW TYPE LB-11A

The aircraft camera pod ASW Type LB-11A (fig. 9-13) is designed for antisubmarine warfare photography from both carrier based and patrol type ASW aircraft. The pod is constructed of aluminum skin on a rigid framework and streamlined to minimize air resistance. Two suspension lugs are bolted to the top surface of the pod for attaching to the carrying aircraft.



PH.494

Figure 9-11.—Flight line tester, E 12301.


115 V
3 Ø
400 Hz
POWER
J1
J2
J3
J4
J6
J5
TO A/C
WIRING
J1
J6
J2
J5
J3
J4
CONVERTER, SIGNAL DATA
CV-1408/AYA-1

PH.495

Figure 9-12.—Flight Line Tester E 12301, cable connections.

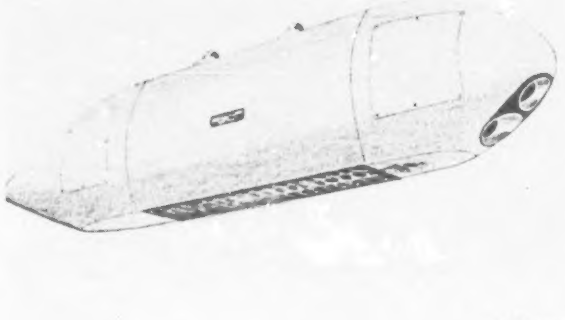


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Figure 9-13.—ASW Aircraft damera pod.

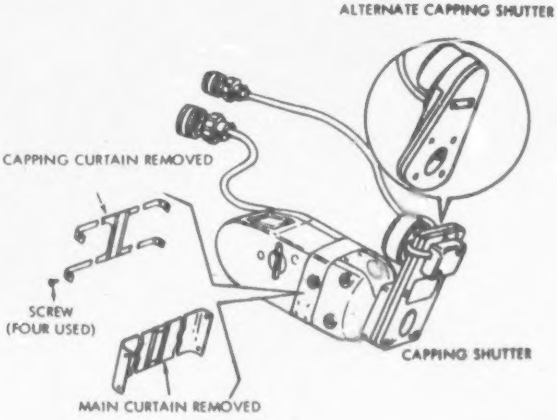

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Figure 9-14.—The KB-16A camera showing alternate shutter.

DESCRIPTION

The pod is designed for use with a KB-16A night camera and a KB-10A day camera when authorized. This pod is restricted to use with M112 cartridges with 1 second or less delay. The day camera is optional equipment and is used only when authorized (on aircraft equipped to control it). Both cameras (when both are used) are mounted in the forward end of the pod at a 30-degree depression angle. Each camera has its own port opening with a protective glass cover mounted in the pod forward of the camera lens. When the day camera is not used, a stiffener bracket is installed in its place to provide rigidity to the pod structure. A 50-foot film magazine is used with each camera and may be removed or installed without removing the cameras mounted in the pod.

The KB-16A camera is a modified KB-10A camera. Modifications include removal of the focal plane shutter; changing the speed of the drive motor, to compensate for the reduced load due to removal of the focal plane shutter; and installation of a capping shutter. Figure 9-14 shows the KB-16A camera with a capping shutter (Gordon Part No. 60A60B-47) attached, and an alternate capping shutter (Lambert Part No. 117-D-000) shown in inset. The KB-16A camera, when issued from stock is equipped with either of these capping shutters.

The KB-16A night camera occupies the area directly above the day camera location in the forward end of the pod. The photographic area covered depends upon the height of the camera above the subject and the attitude of the carrying aircraft. The camera circuit passes through a camera radio noise filter in addition to the JN14-245 pod radio noise filter, through which all circuits pass.

The FLASH DETECTOR BOX contains the flash detector board, programmer, and salvo relay with necessary circuitry for control and operation of these units.

The FLASH DETECTOR SYSTEM consists of a light-sensitive unit (photocell) mounted in the bottom of the nose section of the pod and a transistorized amplifier board mounted in the flash detector box. The photocell senses the flash burst and sends a signal to the control board. Here, the signal is amplified to 28 volts d.c. to trip the capping shutter of the KB-16A camera within 3-5 milliseconds. The system reacts to changes in light levels of 50-foot candles or higher.

The PROGRAMMER is also mounted in the flash detector box. It controls operation of the ASW Photo Pod System. Upon receipt of a 28-volt d-c pulse, the programmer will at timed intervals fire a cartridge, recycle the KB-16A camera, open the capping shutter, energize the flash detector, close the capping shutter (if the cartridge burst is not detected), and start a new picture taking cycle. The programmer also controls the day camera so that pictures are taken at the rate of one picture every 1.5 seconds.

The **SALVO RELAY** provides 28-volt, d-c pulses to the cartridge ejector at the rate of six per second to salvo the cartridges in the ejector.

The lower surface in the pod contains an opening into which fits a **TYPE A-6 PHOTO FLASH CARTRIDGE EJECTOR**. The ejector can be removed or installed without removing the pod from the aircraft. It is a self-contained unit which will fire M112 photoflash cartridges each time a pulse is received from the programmer circuit in the pod. The ejector is equipped with two cartridge retainers, each of which is a rack for supporting 26 of the M112 photoflash cartridges, along with a mechanism for securing them to the ejector in proper firing positions. A multiple-pin power receptacle extends through the sheet metal ejector cover to connect to the power and programmer source in the pod.

INSTALLATION

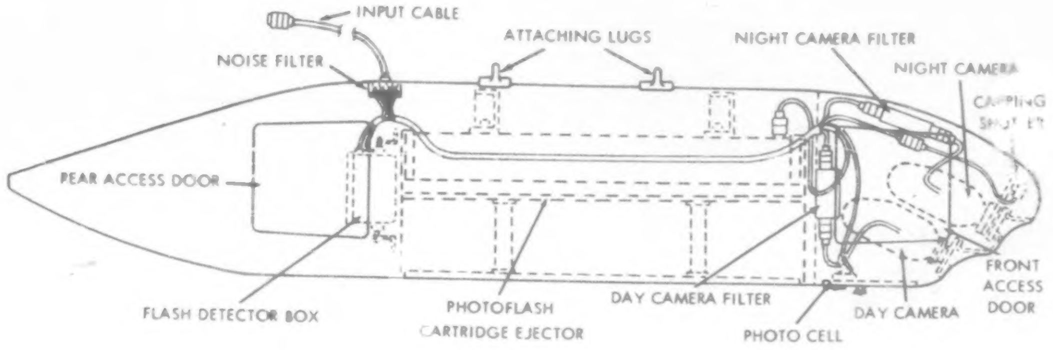
When the pod is removed from the original shipping carton, it is complete except for installation of cameras, film magazines, and camera radio noise filters. These items should be installed prior to attaching the pod to the aircraft. See figure 9-15 for location of components in the pod.

The camera radio noise filters must be installed first. Remove the front access door from the pod and attach the day camera radio noise filter to the pod's forward bulkhead with four capscrews, washers, and nuts. Then attach the night camera radio noise filter to its support with four capscrews. The longest of the capscrews, with a spacer, also attaches the clamp for the capping shutter cable. Make sure this is accomplished when installing the night radio noise filter. Connect the power cables to the radio noise filters.

When installing the night camera make sure the lens aperture diaphragm is set in its wide open position. Also, make sure the yellow filter is located in front of the lens and the capping shutter is secure.

Place the night camera in position between the camera brackets. Install four of the six No. 1/4-20 attaching capscrews. The two topscrews also attach the magazine yoke to the camera bracket. Place the magazine yoke (with yoke spacers attached) on the camera brackets. Aline the holes on the bracket, yoke, and camera, and then secure the yoke with the two remaining screws. Connect the night camera electrical connector to the receptacle of the night camera radio noise filter.

When the day camera is to be installed in the pod, remove the "stiffener" bracket at the day camera location and attach the day camera to its bracket with No. 1/4-20 capscrews. Connect the



PH.498

Figure 9-15.—Location of components in pod.

day camera electrical cable assembly to the electrical receptacle of the day camera radio noise filter.

The magazines are loaded with film in a darkroom prior to installation on cameras in the pod. Install the magazine on the night camera first. In order to prevent damage to the camera magazine during catapult operations, be sure to swing the yoke over the night camera magazine and tighten the thumbscrew to secure it.

Install the day camera magazine (if used). A yoke is not used on the day camera magazine because the day camera is normally used on the type of patrol aircraft that is not catapulted.

Transporting and elevating equipment for moving the pod and elevating it into position under the wing may be of any type which will not dent or otherwise damage the pod. If such equipment is not available, the pod can be handled by two men with relative facility.

The pod is attached to the Aero 14B or Aero 15C combination rack which is suspended from the underside of the aircraft wing. The suspension lugs attached to the top surface of the pod engage the hooks in the combination rack to secure the pod to the aircraft. Lock the hooks in accordance with applicable operation instruction manuals. Tighten the sway braces and connect the cable assembly to the wing receptacle.

CAUTION: Keep photocell cover door closed at all times when pod is not in use. This is to prevent damage to the flash detection system.

The photoflash cartridges are to be installed by ordnance personnel when the aircraft is ready for flight in accordance with existing operational safety regulations, and only after all operational checks have been completed. Installation procedure and other information may be found in the Operation and Maintenance Instructions Manual, Aircraft Camera Pod ASW Type LB-11A, NavWeps 0-1-AK-2.

AIRCRAFT CAMERA PODS LB-30A AND LB-31A

The aircraft camera pods LB-30A and LB-31A provide the F-4, A-6, and A-7 aircraft with strike photographic capability. The basic difference between the two camera pods is that the LB-30A has a longer bolt type strong back for mounting to the F-4 aircraft. (See fig. 9-16.)

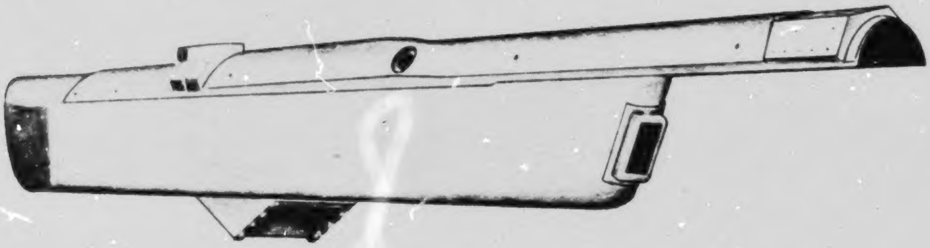
These camera pods are designed to carry the KB-19A 16mm motion picture strike camera and the KB-18B 70mm panoramic still camera with the LB-17A camera control. The LB-30A pod is mounted on the F-4 aircraft in place of the left-hand forward missile launcher by a bolt type strong back. The LB-31A is mounted on the Aero 7A rack on the A-6 type aircraft or the MAU-9A rack on the A-7 aircraft by supporting lugs. Both the forward and aft shells of the two pods are removable. This enables the photographic equipment to be installed in the pods either before or after the pods are mounted on the aircraft.

The forward shell contains the forward heated window and the KB-19A motion picture camera. The aft shell houses the junction box, the LB-17A camera control, and the spring-loaded door counterbalanced cable reel. At the bottom of the body of the pod is a hinged door secured by eleven fasteners, which contain a heated panoramic window. Both the forward window and door window are equipped with conductive coatings for defogging. The door mounts the KB-18B panoramic camera. (See fig. 9-17.)

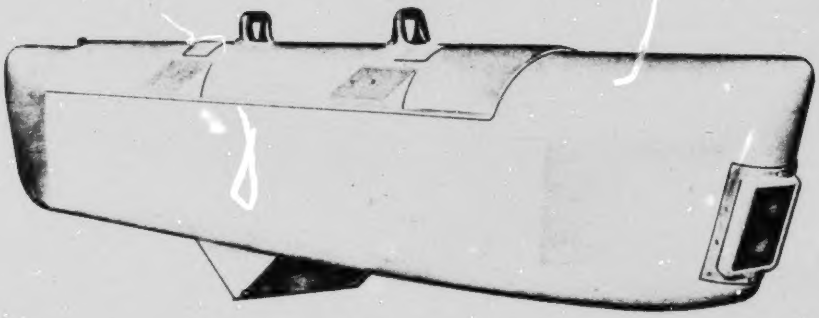
The junction box, KB-19A, KB-18B, LB-17A control box, and the two heated windows are interconnected by a wiring harness terminating at the aircraft cable connector. (See fig. 9-17.) An operating current of 5 amperes a.c./d.c. and an operating voltage of 28 volts d.c. and 115 volts, 400 Hz, a.c. is distributed by the junction box through the wiring harness to the control box, KB-19A, and the two heated windows. A heater safety interlock switch removes the 115-volt, 400 Hz aircraft power from the two heated windows when the door of the camera pod is opened, with the power on. This is to prevent an electrical shock hazard.

WARNING: The following precautions must be observed:

1. Make certain that all electrical power has been removed from the aircraft before interconnecting the wiring harness and that all electrical power has been removed from the camera pod before removing any of the components.
2. Use care when opening the camera pod door when the KB-18B is in position. Always



MODEL LB-30A



MODEL LB-31A

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Figure 9-16.—Aircraft Camera Pods LB-30A and LB-31A.

secure the door in the open position with the door locking bar. Before replacing the spring-loaded counterbalance reel, restrain the cable prior to unbolting the end of the cable from the door. After the cable end is unbolted from the door, gradually relieve the tension on the counterbalance cable. Unbolt and remove the spring-loaded counterbalance reel from its mount and replace.

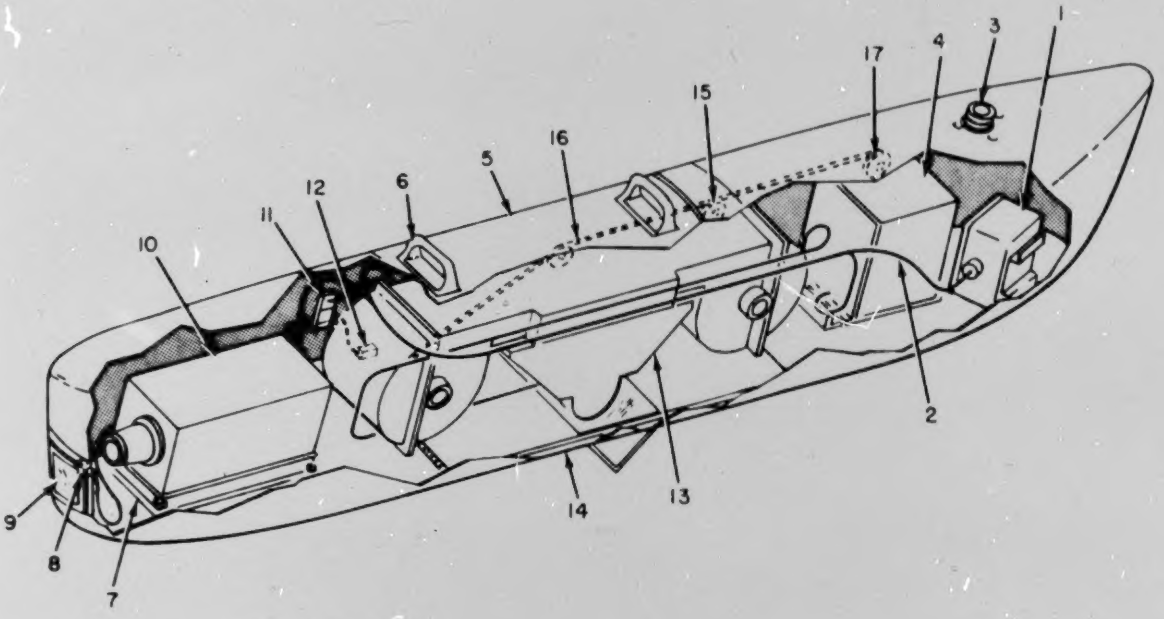
OPERATION OF THE LB-30A AND LB-31A AIRCRAFT CAMERA PODS

The camera pod is controlled through the armament and bomb release circuits of the aircraft, which supply electrical power. (See fig. 9-18.)

The depression angle of the KB-19A camera is adjustable for strike recording from 0 to 150 mils by a wedge type depression mount. The depression screw on the mount is adjusted for the desired depression angle according to the armament being used on the aircraft.

Alternating current at 115 volts, 400 Hz, is supplied to the two heated windows (R1 and R2, fig. 9-18) through the fuse (F1). Direct current at 28 volts is supplied to the fixed contacts of the rocket relay (K1) and the bomb release (K2).

The pan operate relay is also operated to supply 28 volts, d.c., to the frame counter of the KB-18B through the control box. When either the bomb release switch or the trigger switch is activated, a pulse is supplied to the corresponding relay (K1 or K2), operating the relay and



1. Junction box.
2. Wiring harness.
3. Aircraft cable connector J2.
4. LB-17A camera control.
5. Strongback (LB-31A).
6. Support lug.
7. Wedge type depression mount.
8. Connection to window heater R2.
9. Forward heated window.
10. KB-19A 16mm motion picture strike camera.
11. Terminal board TB3.
12. Heater safety interlock switch S1.
13. KB-18B 70mm panoramic camera.
14. Door.
15. Counterbalance cable pulley.
16. Door counterbalance cable.
17. Spring-loaded door counterbalance cable reel.

Figure 9-17.—LB-30A and LB-31A camera location diagram.

supplying 28 volts, d.c., through the control box to the KB-18B and KB-19A cameras. When the auxiliary armament control panel is set to MANUAL, current at 28 volts, d.c., is supplied to both cameras directly through the control box.

LB-30A AND LB-31A MAINTENANCE INSTRUCTIONS

Maintenance of these pods at the squadron level consists of troubleshooting and corrective action, repair, periodic inspection, cleaning, and touchup painting. No special tools are required for maintenance of the camera pods. Troubleshooting of the camera pods may be accomplished by an operational test in the aircraft or by using the LS-101A camera tester. Installation procedure and other information regarding operation and maintenance, along with an illustrated parts breakdown, may be found in the technical manual NAVAIR 10-10AK-6, Operation and Maintenance Instructions with Illustrated Parts Breakdown; Pod, Aircraft Camera Fairing; Model No. LB-30A, LB-31A.

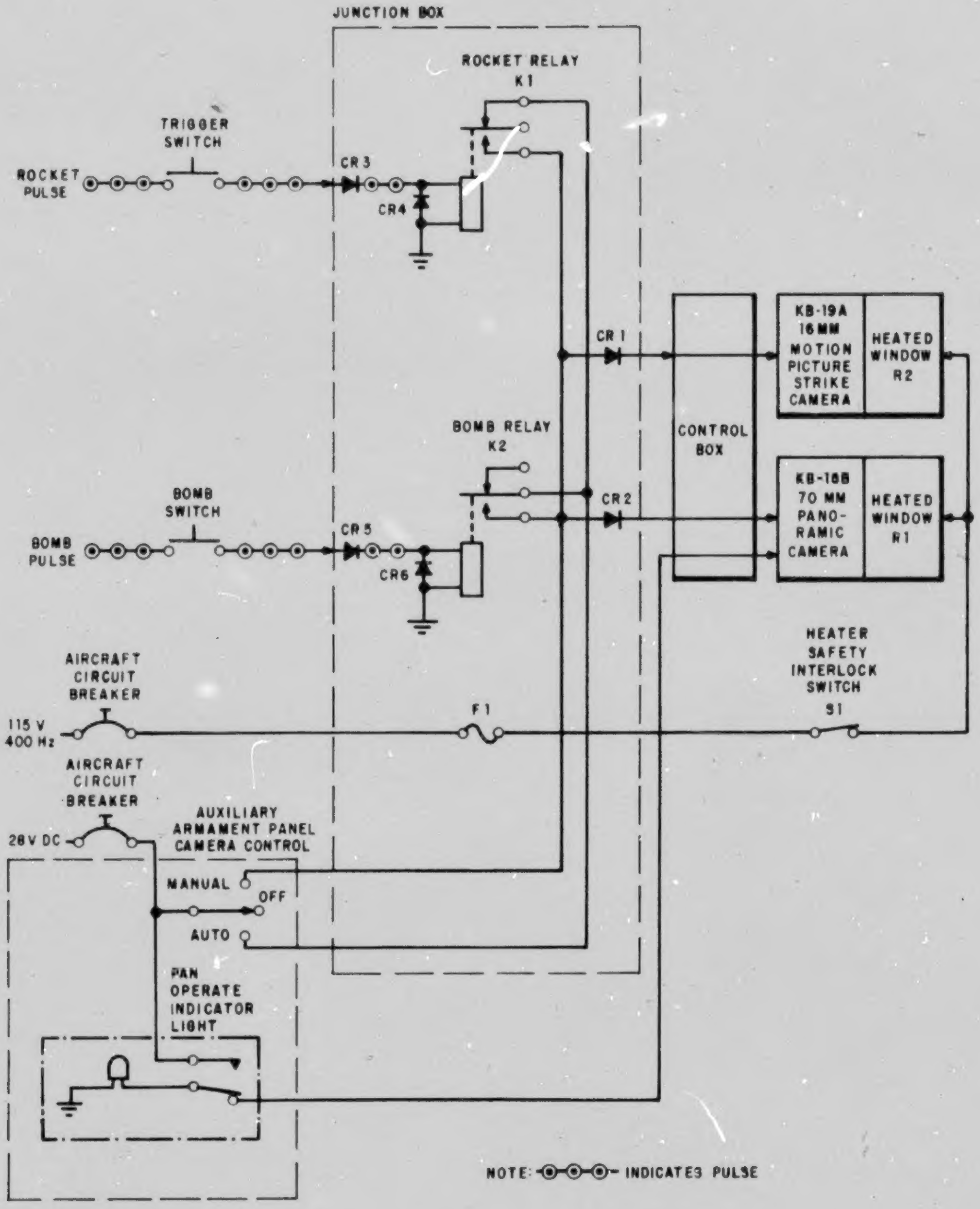

JUNCTION BOX
ROCKET RELAY
K1
TRIGGER SWITCH
ROCKET PULSE
CR3
CR4
CR1
KB-19A 16MM MOTION PICTURE STRIKE CAMERA
HEATED WINDOW R2
CONTROL BOX
BOMB RELAY
K2
BOMB SWITCH
BOMB PULSE
CR5
CR6
CR2
KB-18B 70 MM PANO-RAMIC CAMERA
HEATED WINDOW R1
HEATER SAFETY INTERLOCK SWITCH
S1
AIRCRAFT CIRCUIT BREAKER
115 V 400 Hz
F1
AIRCRAFT CIRCUIT BREAKER
28V DC
AUXILIARY ARMAMENT PANEL CAMERA CONTROL
MANUAL
OFF
AUTO
PAN OPERATE INDICATOR LIGHT
NOTE: -◎-◎-◎- INDICATES PULSE
PH.501

Figure 9-18.—Camera pod functional block diagram.

CHAPTER 10

CAMERA CONTROL SYSTEMS

Aerial cameras contain the fundamental features of a simple camera. They are equipped with a lens, diaphragm, film supply, film takeup, and a device that moves the film so that new pictures can be taken. The early aerial cameras were held and aimed by the photographer, and he had only to control the shutter, set the diaphragm, and rewind the film. The control system for aerial cameras has gradually become more complex as the speed of the aircraft has increased.

Now that aircraft are flying faster and higher, new problems have developed that were not as important to the oldtime aerial photographer. In this chapter some of these problems will be discussed, and it will be shown how they have been solved by various camera control systems.

Generally speaking, there are six problems that have evolved as a result of modern aircraft performance. These problems are concerned with excessive blurring, correct overlap, focus, exposure, the method of calculating time interval signals, and timing marks.

PROBLEMS IN AERIAL PHOTOGRAPHY

Early aerial cameras performed satisfactorily when they were operated at high altitudes and low groundspeeds. However, at low altitudes and high groundspeeds, the pictures were often blurred. Blurring is caused by excessive motion of the image on the film during the exposure. Blurring can be decreased by reducing the exposure time. Nevertheless, this is only a partial cure since short exposure times need greater light intensity which often cannot be obtained.

A second approach to the problem of blurring is to transport film past the focal plane of the camera at the same speed and direction as the image which is being photographed. This compensation is called IMAGE MOTION COMPENSATION (IMC). IMC must take into account the aircraft groundspeed and altitude, the camera focal length, and the camera depression angle. Sharp pictures result when the motion of the film and the image are the same and all other conditions are favorable.

With each exposure, the pulse type aerial camera photographs a definite area of ground. When a continuous course is photographed, it is necessary to provide the proper overlap of pictures. This overlap is desired for stereoscopic viewing and other purposes in aerial photographic interpretation and photo mapping.

For certain military problems, it is necessary to take oblique photographs. This is accomplished by tilting the camera so that the ground is viewed at an angle. However, when the camera is tilted, it has the effect of increasing the altitude, because the distance from the camera to the terrain being photographed becomes greater. The distance varies also from the near ground and the far ground of the oblique view. In this type of installation, scale is of importance. It involves the choosing of the proper focal length camera for the depression angle and altitude of the aircraft in order to provide the proper scale in the area of the oblique desired.

Photographic exposure depends on the illumination striking a film and the time interval that this light is permitted to pass through the lens. In a pulse camera, exposure is a function of factors controlling the illumination and the time interval. These factors are target brightness, f/stop, shutter speed, film sensitivity, and the lens filter. To obtain the correct exposure, all the above factors must be considered.

Photoflash bombs or cartridges are used for illumination sources in modern night photography. After the bombs or cartridges are released from an aircraft, there is a given time interval (fuse time) before each bomb or cartridge explodes. A flash detector, which is sensitive to the rate of change in illumination, is used to detect each bomb or cartridge burst, and to provide a shutter close/camera recycle pulse to the camera.

In addition to the problems just described, there were other serious difficulties with which the earlier systems could not cope. The problems seemed to center on the fact that control of the many functions necessary to the proper handling of modern military aircraft taxed to the utmost the abilities of the pilot and operating personnel. The crew was responsible for such functions as navigation, radar, fire control, radio, and aerial photography. In a single-place aircraft, the pilot alone operated these systems. In multiengine aircraft, one man handled several of these systems. In both cases, the task was so complicated that automatic controls were needed.

CAMERA CONTROL SYSTEM FUNCTIONS

A camera control system serves three purposes, as follows:

1. Provides the operator a common means for starting the operation of the cameras in the photographic system.
2. Provides the operator with automatic and remote manual adjustments of camera parameters, by controlling the rate of exposure required for the desired picture overlap and compensating for image motion during exposure in cameras having image motion compensation (IMC).
3. Provides the operator with controls, operating indications, and failure indications, to enable him to intelligently operate the aircraft's photographic system.

E(v/h) PRINCIPLES

Desired picture overlap and image motion compensation (IMC) may be obtained automatically during day operations by means of a scanner system. The apparent motion of the terrain beneath the aircraft is detected by a scanner, which produces an output signal frequency that is fed into the scanner converter. The scanner converter then generates the control voltage required for the camera control system. Manual control of the system may be obtained whenever it is desired, for example at night, by setting the altitude and speed of the aircraft manually on the master control panel. The control voltage (E) is then generated by a computing circuit.

Determining the rate of apparent image motion of the terrain (target), controlling the rate of exposure for the desired picture overlap, and allowing for image motion compensation (IMC) are factors affected by the ratio of the aircraft's velocity (v) to its height above the terrain (h) and by the required control voltage (E); thus the ratio E(v/h). The velocity/height (v/h) ratio range provided by the scanner is 0.006 to 4.5 and the range provided by the master control panel is from 0.0045 to 4.5.

Theory of Operation

The rate of motion of the terrain (target) image is detected by two photoelectric cells in the scanner. Pulse signals are generated by these two photoelectric cells and transmitted to the scanner converter. The frequency of these pulse signals is in direct proportion to the rate of image motion. These pulse signals are converted into a variable amplitude d-c voltage (E) that is dependent upon the velocity of the aircraft and its height (v/h). The higher the pulse frequency, the greater the E(v/h) amplitude d-c voltage and vice-versa.

The scanner-computer switch when placed in the scanner position transmits the E(v/h) voltage to a variable-speed d-c motor in the central computer. As the pulse frequency increases the E(v/h) increases and the motor runs faster and vice-versa.

This motor in the central computer then drives the four station computers through gear trains located in each station computer. These gear trains may be modified for each station through the use of "shifter" buttons. The function of these buttons is to match the operation of the computer to the format size, focal length, picture overlap and depression angles of the camera installed in that station. Each computer is able to meet the specific requirements of the installed camera by means of both synchro signal and pulse signal outputs, that enable the camera to be operated at a rate controlled by the E(v/h) signal.

The central computer motor also drives a synchro transmitter that controls the speed of the viewfinder traveling grid. Operation of the E(v/h) signal during daylight missions can thus be verified by synchronization of the grid with the viewfinder image. The scanner-computer switch also transmits an E(v/h) signal to the KA-66A and KA-68A camera control units and stations 3 and 4 RDA servo power units. The KA-66A and KA-68A camera systems utilize the E(v/h) signal for automatic IMC and picture taking rate. The servo power units compensate for the selected depression angles of the cameras being controlled by changing the E(v/h) signal.

At night when the computer is inoperative the scanner computer switch is placed in the computer position. Adjust the altitude and knots (altitude-feet/speed-knots) control by manually selecting the aircraft's velocity (speed) and altitude (height) on the altitude-speed indicator to determine the E(v/h) signal.

A camera control system is made up of several components. These components are divided into two basic classifications: the control components and the operational components. The control and operational components of the camera control systems for the RF-8G and RA-5C aircraft will be covered in this chapter.

RF-8G "CRUSADER" CAMERA CONTROL SYSTEM (NCCS-4)

CONTROL COMPONENTS

The following control components of the RF8G (Crusader) camera control system (NCCS-4) can be regulated in flight:

1. Master control panel switches.
2. Flare release and flare reset panel switches.
3. Stations control panel switches.
4. Exposure control switch.
5. Master operate switch.
6. Stick operate switch.
7. Extra-picture-switch.
8. Drift switch.
9. View selector switch.
10. Grid illumination switch.
11. Mode select switch.

The locations of these switches are shown in figure 10-1.

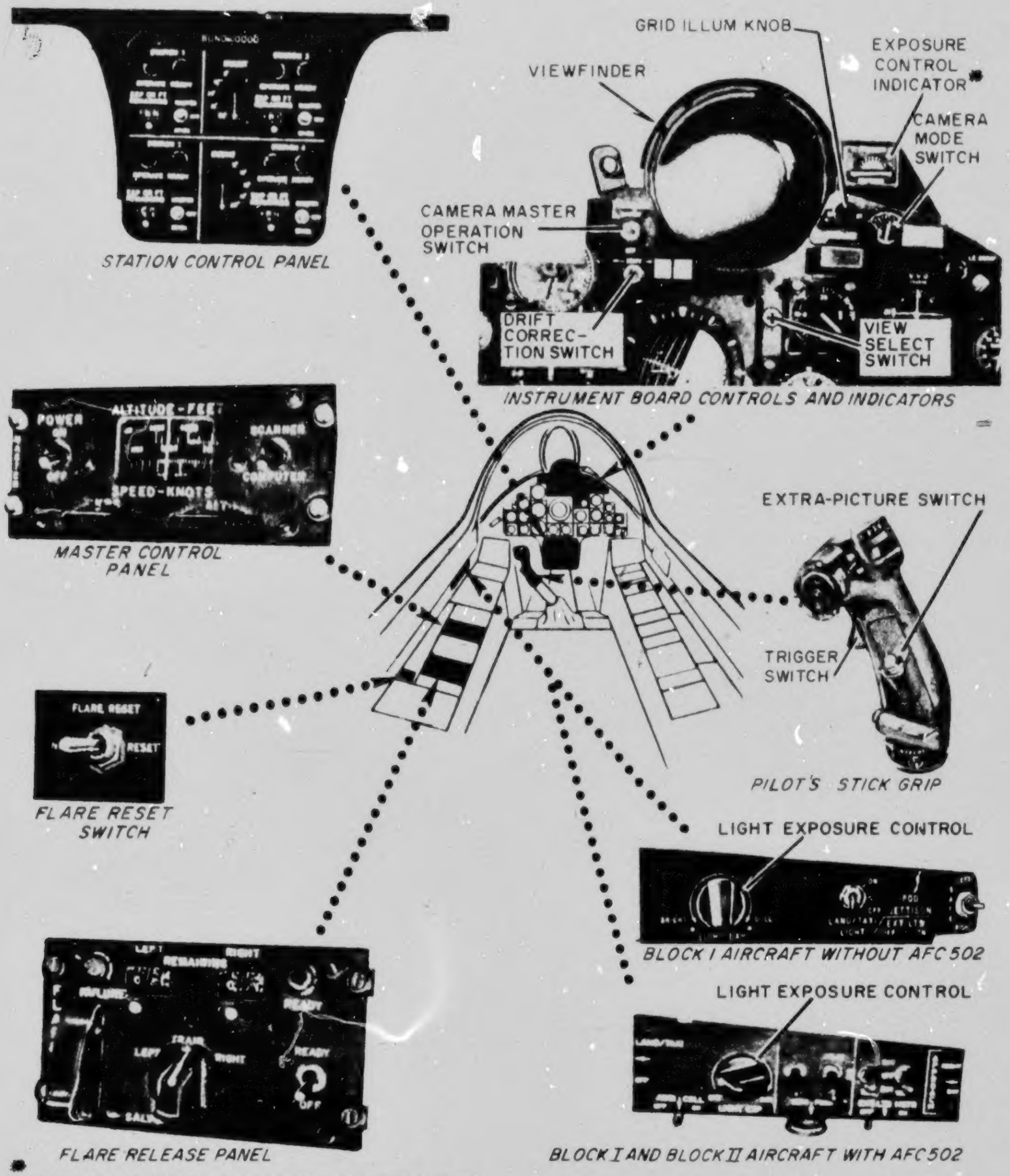
Master Control Panel

This is the main control unit for the entire camera control system. The panel contains an E(v/h) reference signal analog computer and a high-low microswitch, both mounted internally, and the following components located on the front panel: POWER switch, SCANNER-COMPUTER selector switch, ALTITUDE (FEET) SPEED (KNOTS) indicator, KTS control knob, and ALT control knob. (See fig. 10-2.)

The POWER switch energizes or cuts off the power to the entire camera and exposure control system. It energizes the 115-volt, 400-hertz power circuits for the exposure system and the 28-volt d-c and 400 hertz a-c power circuits for all the common system components and camera stations through the stations control unit and the system relay box. Turning on the POWER switch—in addition to energizing the scanner system, the central computer, the exposure system, and the viewfinder—provides a grounding path for the station power relays when the station control switch is in either the stick or master position.

The SCANNER-COMPUTER switch selects the source of the E(v/h) reference signal from either the scanner converter or the master control computer. This signal is a d-c voltage that is directly proportional to the ratio of the aircraft's speed to its height over the terrain. When the switch is placed in SCANNER, it connects a scanner and a scanner converter automatic E(v/h) signal for system distribution. In the SCANNER position, it also connects the scanner converter high-altitude compensating circuit for system distribution.

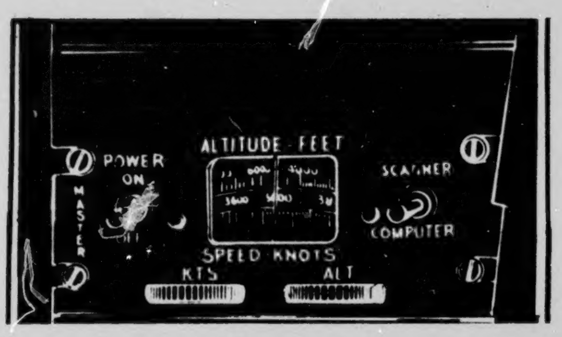
When the SCANNER-COMPUTER switch is placed in COMPUTER, it switches the E(v/h) signal output and the high-altitude compensating circuit output from the scanner and scanner converter to controls in the master control


STATION CONTROL PANEL
GRID ILLUM KNOB
VIEWFINDER
EXPOSURE CONTROL INDICATOR*
CAMERA MODE SWITCH
CAMERA MASTER OPERATION SWITCH
DRIFT CORRECTION SWITCH
VIEW SELECT SWITCH
INSTRUMENT BOARD CONTROLS AND INDICATORS
POWER
ALTITUDE-FEET
SCANNER
SPEED-KNOTS
COMPUTER
MASTER CONTROL PANEL
EXTRA-PICTURE SWITCH
TRIGGER SWITCH
PILOT'S STICK GRIP
FLARE RESET
RESET
FLARE RESET SWITCH
LIGHT EXPOSURE CONTROL
BLOCK I AIRCRAFT WITHOUT AFC 502
LIGHT EXPOSURE CONTROL
LEFT
REMAINING
RIGHT
READY
FLARE
LEFT
TRAIN
RIGHT
READY
OFF
SALVO
FLARE RELEASE PANEL
BLOCK I AND BLOCK II AIRCRAFT WITH AFC 502

* ON BLOCK I AIRCRAFT WITH AFC 479 PART III AND ON BLOCK II AIRCRAFT EXPOSURE CONTROL INDICATOR IS LOCATED ON LEFT-HAND SIDE OF VIEWFINDER.

PH.502

Figure 10-1.—RF-8G cockpit photographic controls.



PH.503

Figure 10-2.—Master control panel.

panel. The master control computer permits the pilot to manually set the speed and altitude dials for the E(v/h) signal. The COMPUTER position is used during night missions or whenever the scanner cannot meet the mission requirements. The ALT and KTS knobs are mechanically coupled to the LATITUDE (FEET) SPEED (KNOTS) indicator, a log-linear analog computer. The knobs may be positioned so that the indicator settings correspond with the aircraft's altitude and speed. The computer then picks off two E(v/h) signal voltages proportional to the ratio of the knob settings. One output voltage is equivalent to 30 times the (v/h) ratio for low-altitude photography. The other voltage is equivalent to 300 times the (v/h) ratio for high altitude photography. Selection of the proper voltage is made automatically by a microswitch. This switch is actuated by a camdriven gear train which is mechanically coupled to the ALT knob. The reason for this voltage shfit is to keep the E(v/h) in a usable range for the central computer speed control circuit.

As the ALT knob is adjusted from 100 feet toward 50,000 feet (as indicated by the ALTITUDE-FEET scale) and reaches approximately the 3,000-foot mark, the high-low switch is actuated to the "high" position. One pole of the switch delivers the 300 (v/h) reference signal through the system's E(v/h) signal circuits. The other switch connects power ground to the system's high-altitude circuits. As the ALT knob is adjusted toward low altitude, the high-low switch is actuated at approximately the 1,500-foot mark, connecting the 30(v/h) signal to the E(v/h) circuits. The 300(v/h) signal and the high-altitude circuits are interrupted. The high-altitude circuit causes the central computer to "shift gears." This shifting is necessary to compensate for the previously mentioned E(v/h) voltage shift so that the camera pulse signals are unaffected.

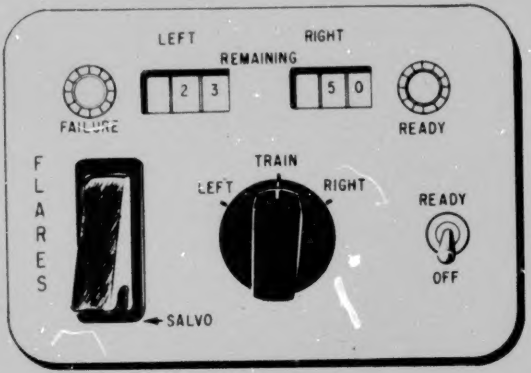
The master control computer may also be used in conjunction with the viewfinder by setting the ALT knob to the aircraft's altitude, then adjusting the KTS knob until the viewfinder traveling gridlines are moving at the same rate as an image on the terrain moves down the viewfinder.

Flare Release Panel

The flare release panel, located on the left-hand console, provides the necessary switching and indicating functions required for effective flare control during night photography. (See fig. 10-3.) The panel contains a READY switch, a 3-position flare selector (LEFT-TRAIN-RIGHT) switch, a SALVO switch, two flare REMAINING counters, a READY light, and a FAILURE light.

The READY switch, when placed in the READY position, connects the flare release panel to the central computer and the flare ejectors, and illuminates the READY light. In addition, the READY switch transfers the KA-45A/51/53/62 cameras in stations 3 and 4 to the night (pyrotechnic) mode of operation and the flash-detector light-monitor unit to the flash detector function. The system provides a landing gear interlock switch (located behind the landing gear handle) which prevents flare ejection when the landing gear handle is DOWN. The READY lamp will not light until the landing gear handle is in the UP position. Flares cannot be ejected by either the camera system OPERATE switch or the SALVO switch until the landing gear handle is UP.

The entire photosystem is placed in the night mode of operation whenever the flare READY light is placed in the ON position. if the flare READY light is turned on during day mode operations certain components of the day system will malfunction, during operation. The flare remaining counters should be set prior to


LEFT
RIGHT
REMAINING
2 3
5 0
FAILURE
READY
FLARES
TRAIN
LEFT
RIGHT
READY
OFF
SALVO

PH.504

Figure 10-3.—Flare release panel.

flight. These counters are of the subtractive type indicating the number of flares remaining in the racks of each bank of ejectors.

The LEFT-TRAIN-RIGHT switch is for selecting the desired bank of ejectors. In the LEFT position, all flares on the left side are fired, and then the flare fail light will illuminate. Placing the switch in the RIGHT position repeats this operation on the right side. In the TRAIN position all flares will be fired, starting with the left side and then automatically switching to the right side. After all flares have been fired the flare fail light will become illuminated.

Depending upon the position of the switch, flares can be fired from either side at any time as long as there are flares remaining in that ejector. The SALVO switch is used to rapidly eject all of the flares simultaneously from both the left and right ejectors at a rate of 16 flares per second (8 from each side).

The FLARE RESET switch is used to reset the flare ejector stepper switches, so that flares can be fired. To insure proper resetting it should be energized for at least 5 seconds. The reset switches located in the left and right hand ejector compartments are used to reset the stepping switches to the initial firing position. When the stepping switch is reset an indicator light (ejector reset indicator) on each reset switch panel will be illuminated. When the reset switch is placed in the normal position the light will go out.

Stations Control

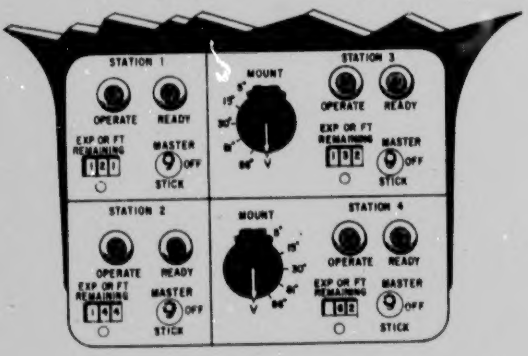
The stations control panel (fig. 10-4), located below the main instrument panel, has individual operating controls and indicators for each of the four camera stations. Each station has a READY light, an OPERATE light, an EXP OR FT REMAINING indicator with a reset knob, and a 3-position switch which reads MASTER-OFF-STICK. In addition, stations 3 and 4 have MOUNT switches for rotating the motor-driven rotatable camera mounts to the desired camera depression angle.

OPERATION: MASTER-OFF-STICK.—When the master-off-stick switch is placed in MASTER, the camera or cameras for that station will be operated by the master CAMERA OPERATE switch.

When the MASTER-OFF-STICK switch for any station is placed in the OFF position, the operate and power circuits for that station are deenergized.

When the switch for any station is placed in STICK, that station will be operated by the STICK OPERATE switch on the yoke.

The EXP OR FT REMAINING counter for each station indicates the exposures remaining in that particular camera. A small knurled knob below the indicator permits the dial to be set to a number corresponding to the amount of film in the camera. Each time an exposure is made, a


STATION 1
OPERATE
READY
EXP OR FT REMAINING
1 2 1
MASTER
OFF
STICK
MOUNT
5°
15°
30°
V
STATION 3
OPERATE
READY
EXP OR FT REMAINING
1 3 2
MASTER
OFF
STICK
STATION 2
OPERATE
READY
EXP OR FT REMAINING
1 4 4
MASTER
OFF
STICK
MOUNT
5°
15°
30°
V
STATION 4
OPERATE
READY
EXP OR FT REMAINING
MASTER
OFF
STICK

PH.505

Figure 10-4.—Stations control panel.

pulse is sent from the camera station to the counter solenoid.

The READY LITE of each station will light when its corresponding MASTER-OFF-STICK switch is in MASTER or STICK position, when all connections relative to the station are properly made. (The system requires up to 60 seconds to warm up before the light will illuminate.) All stations OPERATE indicators are intermittently energized and flash when the corresponding camera stations are operating properly. However, if a film breakage occurs, or the film magazine runs empty, the lamps burn steadily.

The MOUNT switches for stations 3 and 4 control the position of the rotatable mounts for these stations (when installed). The depression angle of the camera in the rotatable mount in station 3 may be adjusted by the station 3 MOUNT switch to 5, 15, 30, 81, 86, or 90 degrees to the left of aircraft vertical. The station 4 camera in the rotatable mount may be adjusted to the same degrees to the right of vertical.

Exposure Control Panel

The exposure control indicator (fig. 10-1), also referred to as an exposure meter or galvanometer, indicates by f/stop increments the proper exposure control setting for the existing target lighting. The exposure control system for the KA-45A camera is properly adjusted for average conditions when the meter pointer is at the midscale (normal) position of the indicator. A maximum of two f/stops underexposure or overexposure is indicated by the relative position of the pointer to the midscale position. The operator can, at his discretion, vary the amount of exposure received by the film one to two f/stops from normal by means of the light exposure switch.

LIGHT EXPOSURE SWITCH.–Rotating the light exposure switch regulates the exposure scale indicator by controlling the amplitude of the exposure signal so that it will match the exposure setting.

MASTER OPERATE SWITCH.–This switch (fig. 10-1) located on the instrument panel, to the left of the viewfinder, provides a master control switch for continuous camera operation. The cameras to be operated by the switch must be selected by placing the applicable station control MASTER-OFF-STICK switches to MASTER. When the MASTER CAMERA OPERATE switch is placed in OPERATE, the selected cameras will operate until the film supply is exhausted or the switch is turned OFF.

STICK OPERATE SWITCH.–This switch, located on the pilot's stick (fig. 10-1), serves the same purpose as the MASTER CAMERA OPERATE switch, except that it is a momentary-contact switch and must be held depressed during operation. The cameras to be operated by this switch must be selected by placing the applicable station control MASTER-OFF-STICK switch in STICK.

EXTRA-PICTURE SWITCH.–This switch (fig. 10-1), located on the pilot's stick grip, serves two functions. It may be used as an override switch for either stick or master operation. In addition, it provides an alternate control if the normal control system fails. If a station control MASTER-OFF–STICK switch is in either STICK or MASTER, the applicable camera will be operated when the extra picture switch is depressed. Single exposures may be obtained by momentarily depressing the switch. If the switch is held depressed, runaway operation results except that, during night operation, one flare is ejected each time the switch is pressed and released.

DRIFT SWITCH.–This switch (fig. 10-1), located on the instrument panel, is used to rotate the drift reticle in the viewfinder to the right or left to determine the amount of drift encountered due to the wind's action on the aircraft.

VIEW SELECTOR SWITCH.–This switch (fig. 10-1), located on the instrument panel is used to adjust the viewfinder for either wide angle or narrow angle viewing.

GRID ILLUMINATION SWITCH.–This switch (fig. 10-1), located on the instrument panel, is used to turn the viewfinder traveling grid lamp on or off, and it varies the brightness.

MODE SELECT SWITCH.–This switch is located on the instrument panel (fig. 10-1). It provides selection of the mode of day operation desired, for the cameras in stations 3 and 4 during flight. The "IMC PULSE" position furnishes image motion compensation (IMC) during flight. The "AUTO" position bypasses the central computer to provide IMC operation at a fixed 60 percent overlap. The "PULSE" position of the mode select switch provides operation of the camera in stations 3 and 4 without IMC.

RF-8G CAMERA CONTROL SYSTEM (NCCS-4) OPERATIONAL COMPONENTS

The operational components of the NCCS-4 illustrated in figures 10-5 and 10-6 cannot normally be adjusted during flight.

CAPABILITIES AND LIMITATIONS

The following paragraphs present information that will aid in making preflight adjustments to the cameras and photographic control equipment of the RF-8G. Camera limitations and formulas for determining various photographic parameters are discussed under separate headings for each type of camera used. A description of the means of obtaining the (v/h) ratio is also presented.

The photographic control system provides two means for establishing (v/h) ratio information that regulates picture-taking frequency and image motion compensation rates. In the COMPUTER mode, manual settings are made on the master control panel for speeds from 150 knots to 1,000 knots and for altitudes from 100 feet

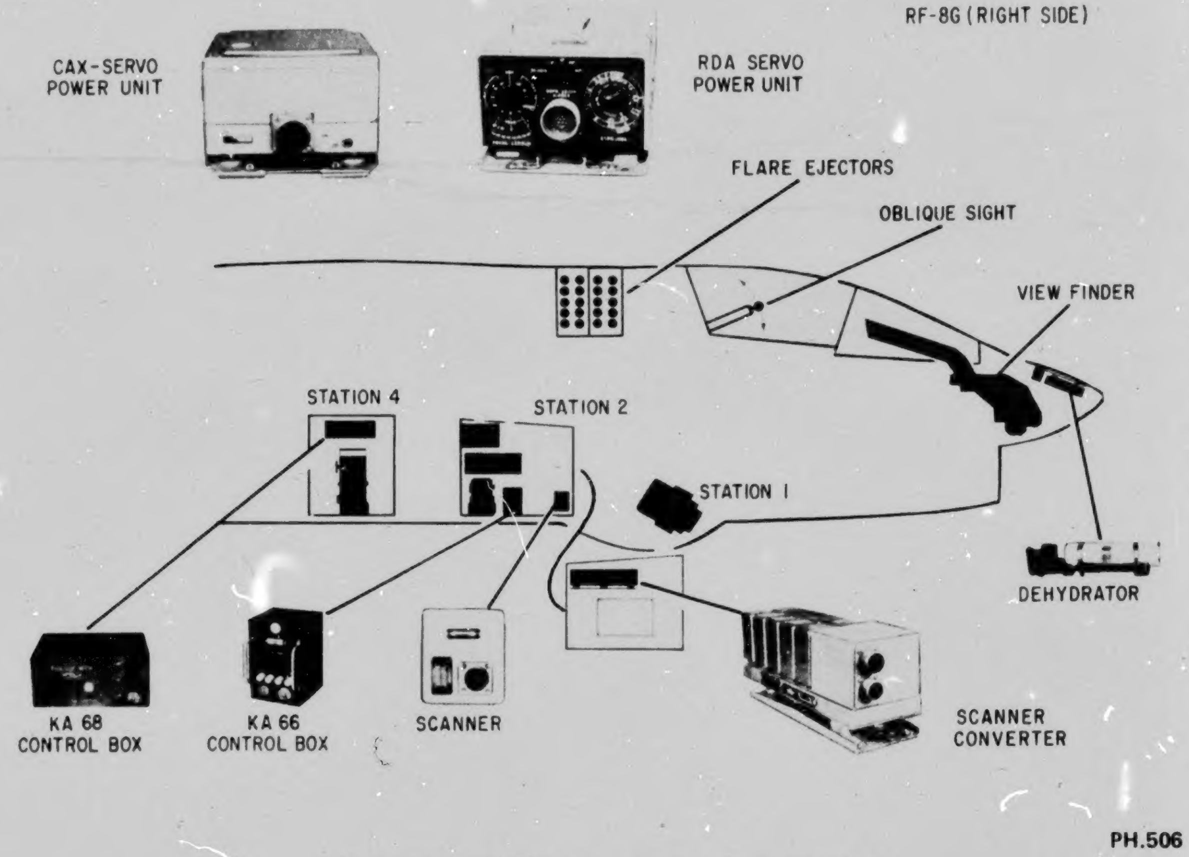
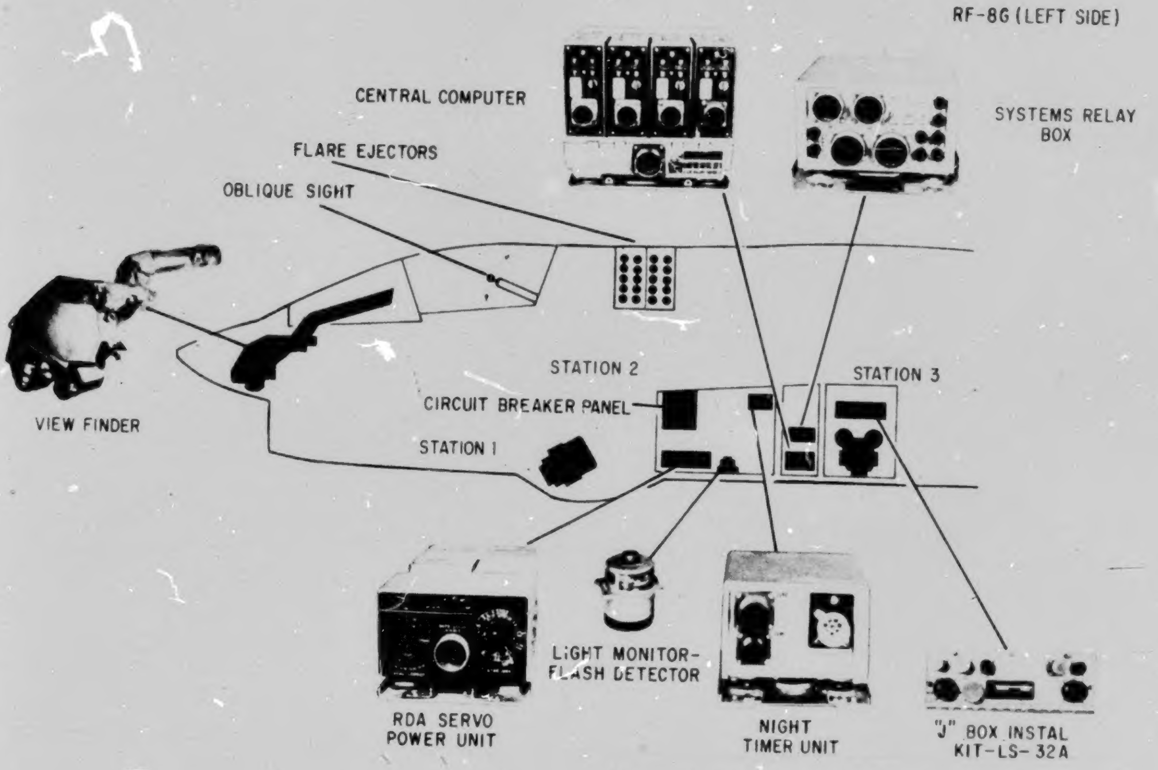

RF-8G (RIGHT SIDE)
CAX-SERVO POWER UNIT
RDA SERVO POWER UNIT
FLARE EJECTORS
OBLIQUE SIGHT
VIEW FINDER
STATION 4
STATION 2
STATION I
DEHYDRATOR
KA 68 CONTROL BOX
KA 66 CONTROL BOX
SCANNER
SCANNER CONVERTER
PH.506

Figure 10-5.–RF-8G camera control system (right side).


RF-8G (LEFT SIDE)
CENTRAL COMPUTER
SYSTEMS RELAY BOX
FLARE EJECTORS
OBLIQUE SIGHT
VIEW FINDER
STATION 2
STATION 3
CIRCUIT BREAKER PANEL
STATION 1
LIGHT MONITOR-FLASH DETECTOR
RDA SERVO POWER UNIT
NIGHT TIMER UNIT
"J" BOX INSTAL KIT-LS-32A

PH.507

Figure 10-6.—RF-8G camera control system (left side).

to 50,000 feet. The master control unit provides a (v/h) ratio range from 0.0045 to 4.5. In the SCANNER mode, the high-altitude scanner system automatically provides (v/h) ratio over a range from 0.006 to 4.5.

Scanner

The purpose of the scanner is to generate an output signal with a frequency which is proportional to the ratio of aircraft groundspeed to altitude. The scanner consists of a dual optical and photoelectric cell system together with a preamplifier, mounted in a gyrostabilized cradle.

Gyrostabilization is provided to prevent the error which would be introduced by motion of the aircraft about the pitch axis. The gyroscope has an automatic caging mechanism which erects the gyro with respect to its mounting frame whenever it spills beyond a specified angle. This mechanism also holds the gyro in the caged position when the 28-volt d-c power supply is off. This prevents the possibility of damage to the gyro and bearings due to unrestrained movement when the motor is inoperative.

The scanner automatically produces an electrical a-c sine wave with a frequency which is proportional to the ratio of aircraft groundspeed to aircraft altitude. This information is amplified and fed to the scanner converter, where it is used to establish an output reference voltage E(v/h) proportional to the frequency.

The scanner is mounted with the common centerline through the lens system parallel to the longitudinal centerline of the aircraft so that one lens system precedes the second in flight. An image of the portion of terrain below the aircraft which is in the field of the objective lens is formed on the surface of an optical grating placed between the lens and the photo cell. (See fig. 10-7.)

This grating consists of a series of transverse opaque lines etched on a strip of glass. During flight, the image of a ground object therefore moves across the bands of equal width which are alternately opaque and transmitting.

The lenses are phased with respect to each other so that as the light on one cell increases due to a bright image moving into a clear area on the grid, the light on the second cell is decreasing because the image is moving into an opaque area. In this manner a signal is generated which is a function of image velocity. Because the lens systems are effectively 180 degrees out of phase and in a push-pull circuit, the signal amplitude is doubled and changes in ambient light are canceled. The signal is amplified and sent to the scanner converter.

Scanner Converter

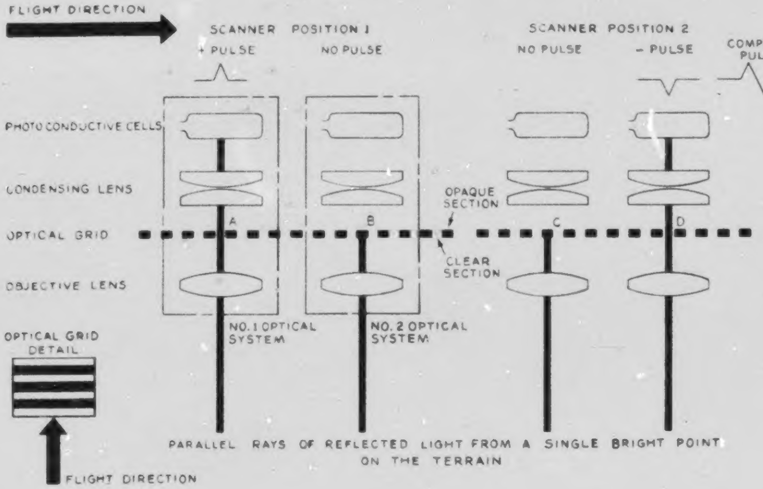
This unit, located in the right-hand station 2 compartment, is an automatic electronic device which operates without attention or adjustment during flight. Its purpose is to convert the output signal frequency of the scanner into a d-c voltage which is proportional to the ratio of groundspeed to altitude (v/h). This output signal serves as the E(v/h) reference voltage for the camera control system. The scanner converter is an integral part of the scanner system and is always used when the E(v/h) is determined by the automatic method.

Central Computer Assembly

The purpose of the central computer is to give pulse signals and synchro information required for control of certain installations, to control the speed of the viewfinder traveling grid, and supply regulated 150-volt d-c power to the log-linear potentiometer (alt/speed) in the master control. As an integral part of the central computer, there are four station computers that provide individual camera control to each camera station.

The central computer consists of an amplifier unit, a base assembly, and four station computers. It provides synchro information and timed pulses proportional to the input signal (E(v/h)).

The base assembly contains a drive motor and a tachometer on a common shaft. The synchro


FLIGHT DIRECTION
SCANNER POSITION 1
+ PULSE
NO PULSE
SCANNER POSITION 2
NO PULSE
– PULSE
COMPOSITE PULSE
PHOTO CONDUCTIVE CELLS
CONDENSING LENS
OPAQUE SECTION
A
B
C
D
OPTICAL GRID
CLEAR SECTION
OBJECTIVE LENS
NO. 1 OPTICAL SYSTEM
NO. 2 OPTICAL SYSTEM
OPTICAL GRID DETAIL
PARALLEL RAYS OF REFLECTED LIGHT FROM A SINGLE BRIGHT POINT ON THE TERRAIN
FLIGHT DIRECTION

PH.508

Figure 10-7.—Scanner optical schematic diagram.

which controls the viewfinder traveling grid is also mounted in the base and driven through a hysteresis clutch by this motor.

The amplifier unit contains the components and circuitry required for drive motor speed control and for a 150-volt d-c regulated power supply source.

The station computers contain the gear trains necessary to adjust their output rate for the appropriate camera format size, overlap, focal length, and depression angle. The function of the station computers is to supply pulse signals or synchro information as required for the control of their respective camera station. The station computers are driven by the drive motor in the base assembly.

CAX-12 Servo Power Unit

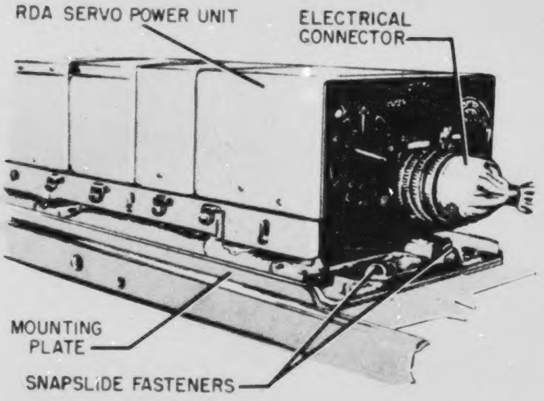
This unit (fig. 10-5), installed in the aft area of the right hand station 2 compartment, provides exposure control for the KA-45A camera installed in station 1.

RDA Servopower Unit

The RDA servopower unit (fig. 10-8) consists of six detachable component units which plug into a common base, the units being interconnected through means of cabling in the base. The six component units are:

1. Computation and switching unit.
2. Drive amplifier.
3. Log-linear converter.
4. Log-linear servoamplifier.
5. Power supply unit.
6. Variable gain amplifier.

The front panel mounts a DEPRESSION ANGLE control, a FOCAL LENGTH control, and an EXPOSURE control, which are manually set at the same time that the camera and/or magazine equipment is installed. The RDA servopower unit for camera station 4, is installed in station 2 on the right-hand side. The unit for station 3 is installed in station 2 on the left-hand side (figs. 10-5 and 10-6). This unit is used for the KA-50 and KA-60 series cameras in stations 3 and 4.



PH.509

10-8.—RDA servopower unit.

System Relay Unit

This unit, located in the computer compartment (fig. 10-6), provides the switching circuitry required to effectively control and operate the camera control systems.

Adapter Junction Box (Centerline Box)

This unit is located at camera station 3 to provide the necessary camera mode transfer functions and to join the existing station control cables, the added wiring harness, and the camera cables for adaption of the KA-45/51A/53A/62A cameras to the NCCS-4.

Light Monitor/Flash Detector

This unit, located in the left-hand station 2 compartment (fig. 10-6), functions to measure reflected light from the terrain on day missions and to detect the flash from a flare at night. The functions are controlled by a transfer relay located within the unit. The unit operates as a light monitor in the deenergized position on the relay. When the flare release panel READY switch is ON, a night 28-volt d.c. energizes the relay for flash detection operation. The light monitor detects reflected light from the terrain, converts it into d.c., and directs it to the exposure meter on the exposure control panel.

The flash detector detects the flash from a flare and generates an electrical pulse.

Night Timer Unit

This unit incorporates both a flash detector control and a hermetically sealed night overrun control section. Both the flash detector control and the overrun control section of the night timer unit are used in the night configuration only.

The flash detector control section accepts preamplified, pulsed output signals from the flash detector unit. It amplifies and delivers the signal to a thyratron-controlled, relay-operated timing control circuit. This circuit time-controls a relay whose operation energizes the camera shutter's trip pulse control system (through sequential relays), provided that either the CAMERA OPERATE switch or the STICK OPERATE switch is placed in the ON position.

The overrun control section of the night timer unit incorporates three pressure-sensitive switches which are sequentially operated by shaft-mounted cams, driven by a d-c motor through means of a combination solenoid/return spring and shaft-mounted clutch (fig. 10-6). The camera-operated switches connect to contacts of a relay. This relay is energized from the night +28-volts d-c circuit when the READY control on the flare release panel is placed in READY. The overrun control section functions when either the CAMERA OPERATE switch, stick switch, or extra-picture switch is set to ON. The overrun control section delays, for 6 seconds, the opening of the auxiliary operate ground after the MASTER or STICK OPERATE switch has been placed in the OFF position. This insures continued operation of camera stations 3 and 4 until the last flare has burst.

ROTATABLE CAMERA MOUNTS

These mounts are for use with the KA-45A/51A/53A and 62A cameras. These cameras are driven by the RDA servopower unit in the IMC modes of operation. The rotatable mount depression angle switch provides switching of the RDA to the station computer. The remote switching provides the correct IMC to the KA-45A/51A/53A and 62A cameras in all positions except the 5-degree position. In the 5-degree position the non-IMC mode is used. The remote switching to the station computer provides the correct pulse rate for 60 percent overlap in the vertical position and 80 percent overlap in the 30-degree, 15-degree and 5-degree positions.

RA-5C CAMERA CONTROL SYSTEM

The RA-5C aerial photographic camera control system is composed of two separate systems. One system controls the still picture cameras; the other controls the panoramic cameras. Within the overall system, certain components can be used with either the still picture camera control system or the panoramic camera control system, or both.

CONTROL COMPONENTS

All cameras are controlled from a camera control panel located in the radar air-navigator's compartment. The pilot has the capability of controlling the three oblique cameras from a control panel located in the cockpit. For the location of these control panels and other controls and indicators, refer to figure 10-9.

A positive d-c voltage (Vg/H), supplied by the signal data converter, CV-1408/AYA-1, is received by the camera control and electronic components for camera operation and image motion compensation (IMC). This signal is used for controlling still picture and panoramic camera film drive and panoramic camera lens operation. Low-level, high-resolution aerial photography is accomplished through the use of this signal. All cameras except the oblique and azimuth vertical cameras are stabilized by electronically controlled camera mounts against pitch, roll, and drift motions of the aircraft. The azimuth vertical camera has control for drift only. These stabilization signals are received from the data converter. In the event of a failure of the data converter or other units, the radar air-navigator can manually control the optical viewfinder to supply corrected Vg/H and drift signals to the camera systems. (See fig. 10-10.) Fixed data signals (which are not part of the

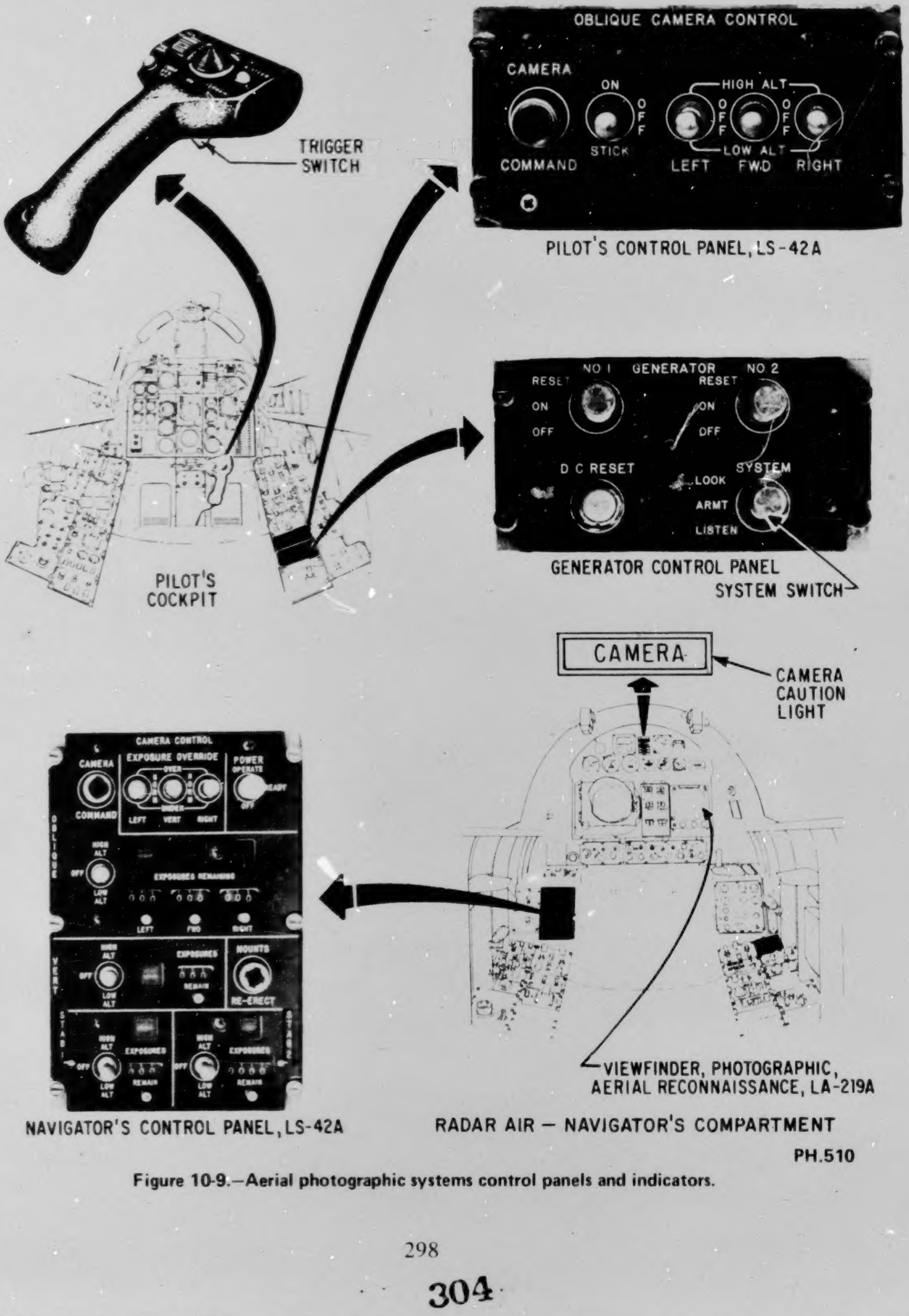
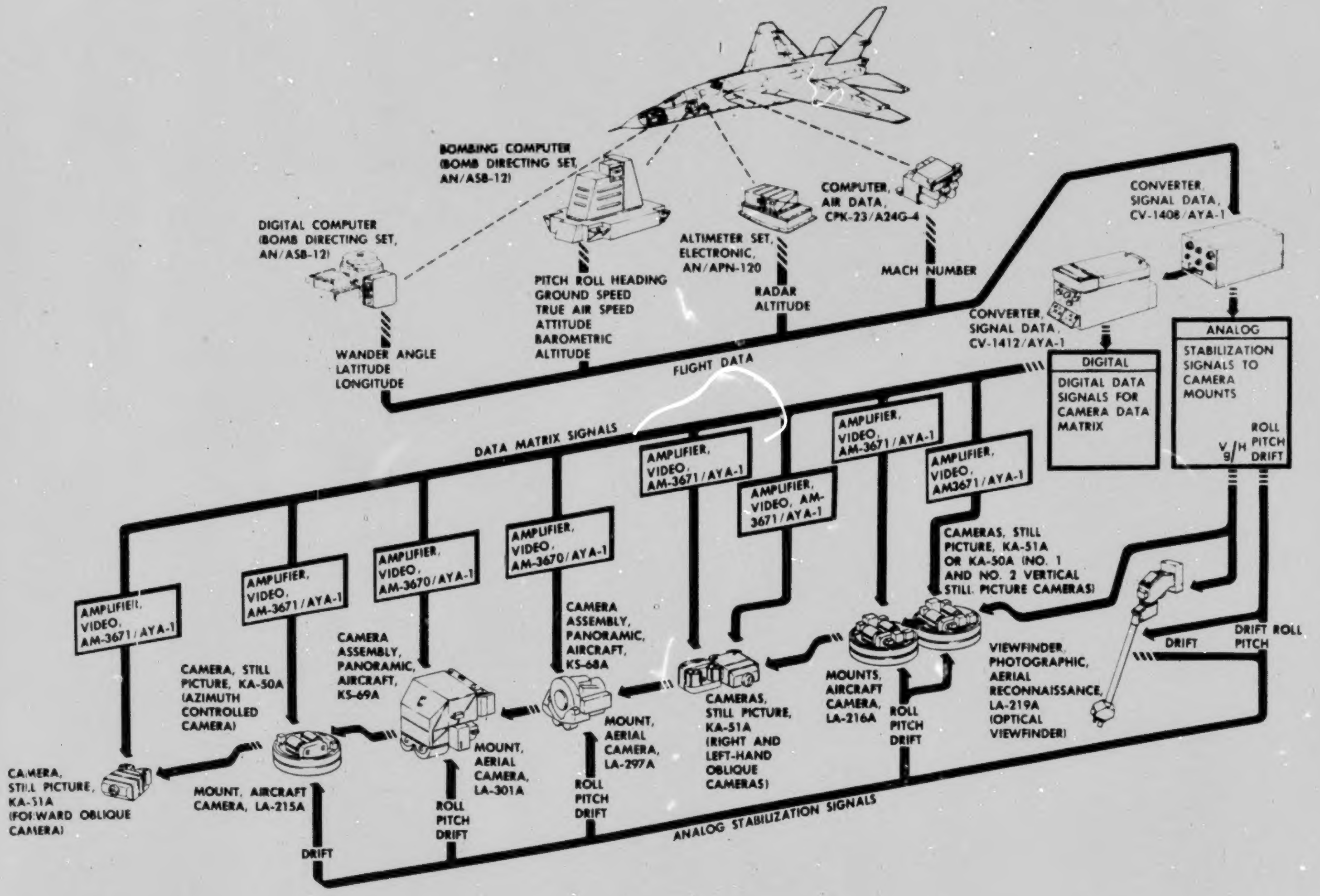

OBLIQUE CAMERA CONTROL
CAMERA
COMMAND
ON
OFF
STICK
HIGH ALT
LOW ALT
OFF
OFF
LEFT
FWD
RIGHT
PILOT'S CONTROL PANEL, LS-42A
TRIGGER SWITCH
PILOT'S COCKPIT
NO. 1
GENERATOR
NO. 2
RESET
ON
OFF
RESET
ON
OFF
D C RESET
SYSTEM
LOOK
ARMT
LISTEN
GENERATOR CONTROL PANEL
SYSTEM SWITCH
CAMERA
CAMERA CAUTION LIGHT
CAMERA CONTROL
CAMERA
COMMAND
EXPOSURE OVERRIDE
OVER
UNDER
LEFT
VERT
RIGHT
POWER
OPERATE
READY
OFF
OBLIQUE
HIGH ALT
OFF
LOW ALT
EXPOSURES REMAINING
LEFT
FWD
RIGHT
VERT
HIGH ALT
OFF
LOW ALT
EXPOSURES
REMAIN
MOUNTS
RE-ERECT
STAB 1
HIGH ALT
OFF
LOW ALT
EXPOSURES
REMAIN
STAB 2
HIGH ALT
OFF
LOW ALT
EXPOSURES
REMAIN
NAVIGATOR'S CONTROL PANEL, LS-42A
VIEWFINDER, PHOTOGRAPHIC, AERIAL RECONNAISSANCE, LA-219A
RADAR AIR — NAVIGATOR'S COMPARTMENT
PH.510

Figure 10-9.—Aerial photographic systems control panels and indicators.


BOMBING COMPUTER (BOMB DIRECTING SET, AN/ASB-12)
DIGITAL COMPUTER (BOMB DIRECTING SET, AN/ASB-12)
ALTIMETER SET, ELECTRONIC, AN/APN-120
COMPUTER, AIR DATA, CPK-23/A24G-4
CONVERTER, SIGNAL DATA, CV-1408/AYA-1
CONVERTER, SIGNAL DATA, CV-1412/AYA-1
WANDER ANGLE
LATITUDE
LONGITUDE
PITCH ROLL HEADING
GROUND SPEED
TRUE AIR SPEED
ATTITUDE
BAROMETRIC ALTITUDE
RADAR ALTITUDE
MACH NUMBER
FLIGHT DATA
DIGITAL
DIGITAL DATA SIGNALS FOR CAMERA DATA MATRIX
ANALOG
STABILIZATION SIGNALS TO CAMERA MOUNTS
V/H ROLL PITCH DRIFT
DATA MATRIX SIGNALS
AMPLIFIER, VIDEO, AM-3671/AYA-1
AMPLIFIER, VIDEO, AM-3671/AYA-1
AMPLIFIER, VIDEO, AM-3670/AYA-1
AMPLIFIER, VIDEO, AM-3670/AYA-1
AMPLIFIER, VIDEO, AM-3671/AYA-1
AMPLIFIER, VIDEO, AM-3671/AYA-1
AMPLIFIER, VIDEO, AM-3671/AYA-1
AMPLIFIER, VIDEO, AM3671/AYA-1
CAMERAS, STILL PICTURE, KA-51A OR KA-50A (NO. 1 AND NO. 2 VERTICAL STILL PICTURE CAMERAS)
VIEWFINDER, PHOTOGRAPHIC, AERIAL RECONNAISSANCE, LA-219A (OPTICAL VIEWFINDER)
DRIFT
DRIFT ROLL PITCH
MOUNTS, AIRCRAFT CAMERA, LA-216A
ROLL PITCH DRIFT
CAMERAS, STILL PICTURE, KA-51A (RIGHT AND LEFT-HAND OBLIQUE CAMERAS)
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KS-68A
MOUNT, AERIAL CAMERA, LA-297A
ROLL PITCH DRIFT
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KS-69A
MOUNT, AERIAL CAMERA, LA-301A
ROLL PITCH DRIFT
CAMERA, STILL PICTURE, KA-50A (AZIMUTH CONTROLLED CAMERA)
MOUNT, AIRCRAFT CAMERA, LA-215A
DRIFT
CAMERA, STILL PICTURE, KA-51A (FORWARD OBLIQUE CAMERA)
ANALOG STABILIZATION SIGNALS

PH.511

Figure 10-10.—Aerial photographic systems camera stabilization and data recording diagram.

camera control), consisting of information regarding date, squadron number, camera number, etc., are supplied to all cameras by the signal data converter, CV-1412/AYA-1 (data translator). This information is presented on the film for use with each photograph during postmission analysis. Light sensors associated with each camera provide signals to the automatic exposure control circuits for control of film exposure. Controls are provided on the navigator's control panel to manually override these light sensor signals if necessary.

To keep the camera control components and cameras operational, the RA-5C is also equipped with a cooling air system, a liquid cooling system, and a vacuum source. The cooling air system is routed into the camera bays from the aircraft heat and vent system to cool the cameras and associated equipment and maintain them at a preset level. The liquid cooling system is separate and contained in the panoramic camera modules to provide cooling to the high-heat density areas of the cameras, mounts, mount electronics, and control electronics. The vacuum source, provided by two vacuum pumps located in the left engine nacelle, is connected to each still picture camera for the purpose of flattening the film against the platen during exposure.

Operating Components

Those parts of the camera control system best described as operating components are those controls requiring manual setting or operation. The most important controls of this nature are the following:

1. PILOT'S CAMERA CONTROL PANEL. The pilot's control panel permits the pilot to operate the three oblique still picture cameras in continuous or intermittent operation. Although the navigator also has control of the oblique cameras, the pilot can take control of the cameras by depressing his CAMERA COMMAND button provided that the navigator does not actuate or hold his camera command button switch depressed. There are five switches on the pilot's control panel (See fig. 10-9.)

The CAMERA COMMAND switch, when depressed, transfers control of the oblique cameras from the navigator's panel to the pilot's panel. A green light within the switch informs the pilot he has control of the oblique cameras. The ON-OFF-STICK switch is a three position switch that allows the pilot to operate preselected oblique cameras by two methods. When the switch is in the ON position, d-c power ground is connected to one side of the mode switches and the selected cameras will operate continuously until the switch is returned to the center (OFF) position. When the switch is in the STICK position, the operate circuit is connected through the trigger switch on the pilot's control column. As long as the pilot squeezes the trigger switch, the cameras will operate. When the trigger is released the cameras stop.

The three MODE SELECTOR switches, one for each oblique camera, allows the pilot to select a particular mode of operation. The HIGH ALT position provides a "pulse" mode of operation and the LOW ALT position provides the "autocycle" mode of operation for the side oblique cameras and "pulse" mode for the forward oblique camera. The pilot's oblique camera control panel is a single unit secured to the right-hand console. (See fig. 10-9.)

2. NAVIGATOR'S CAMERA CONTROL PANEL. This panel provides the navigator with a means of controlling all cameras in all modes of operation. Also included in the panel are exposure override switches (upper portion of panel), which are provided for the operator to manually override the automatic exposure control circuits of the forward and side oblique cameras; exposures remaining counters; and camera readiness indicators. The OBLIQUE CAMERA COMMAND switch is identical to that on the pilot's control panel. When this switch is depressed an integral green light indicates that command of the oblique cameras has been transferred from the pilot's panel to the navigator's panel. When the POWER switch is in the READY or OPERATE position, control is automatically given to the navigator.

The POWER switch is a three position, lever lock toggle switch which, when moved from the OFF position to the READY position, energizes relays to supply power to those portions of the photographic system which require a warmup period. When moved from READY to the OPERATE position, all preselected cameras begin to operate.

There are four three-position MODE SELECTOR toggle switches that can be used to select the desired camera mode of operation. When the oblique camera switch is set to the HIGH ALT position, a "pulse" mode of operation is provided to all oblique cameras. When this same switch is placed in the LOW ALT position, an "autocycle" mode is furnished to the two side oblique cameras and a "pulse" mode to the forward oblique camera. Unlike the pilot's panel, the navigator's camera control panel cannot select only one or two oblique cameras to operate independently; they all operate simultaneously. The panoramic cameras are also connected to the READY-OPERATE condition of the POWER switch when the 18-inch panoramic camera switch is in HIGH ALT position, and the 3-inch panoramic switch is in the LOW ALT position. Mode of operation selection for the vertical stabilized still picture cameras is achieved with the 18-inch panoramic camera switch for the No. 1 vertically stabilized camera and with the 3-inch panoramic switch for the No. 2 vertically stabilized camera. Flip-type indicators, located in the lower control panel, can be rotated to indicate the type of cameras installed in sensor station 4 area. When a module No. 2 installed containing an 18-inch and 3-inch panoramic camera is installed, these indicators are flipped to read 18" PAN and 3" PAN. When the No. 1 module containing a 3-inch panoramic camera is installed, the 18" PAN mode selector is not used. When the No. 3 module is installed, the indicators are rotated to indicate STAB 1 and STAB 2. The vertically stabilized cameras operate in an "autocycle" mode when the switches are at LOW ALT and in "pulse mode" when the switches are in the HIGH ALT position.

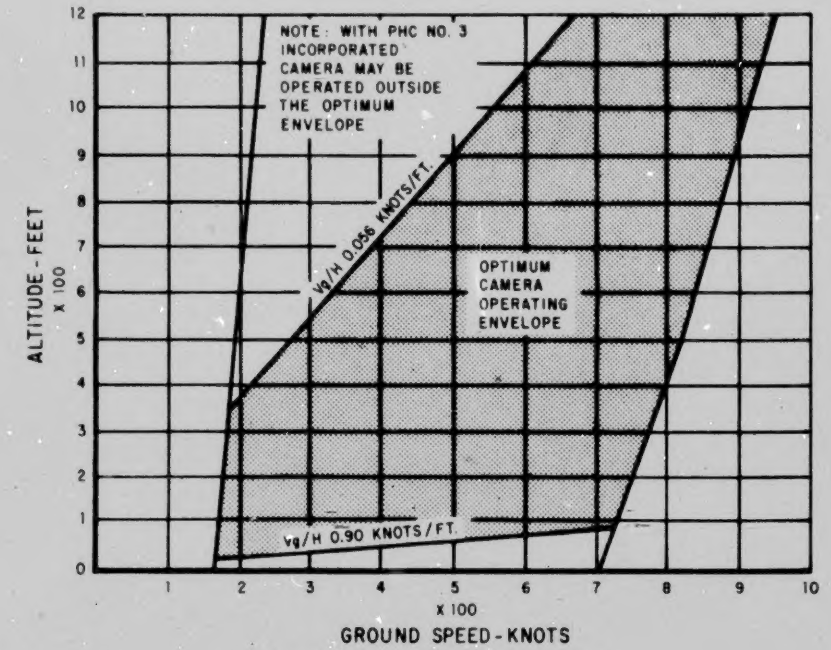
Five three-digit and one four-digit subtractive type, EXPOSURES REMAINING COUNTERS, indicate the number of exposures remaining in each camera. A knob at each counter allows for manual settings during preflight procedures.

Six miniature two-position (flip-flop) indicators display the readiness and operating condition of the camera systems. The indicators read ON when energized (camera systems operating normally) and OFF when deenergized (system fault exists or system turned off).

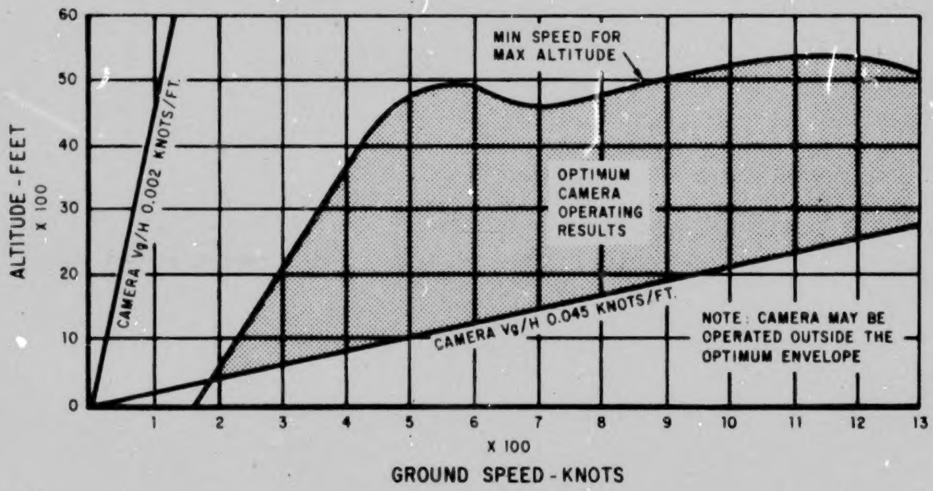
The MOUNTS REERECT switch is a momentary pushbutton switch with a built-in indicator. When depressed, a d-c power ground is provided to initiate a reerect action in the stabilized mounts. The indicator lamp is connected to the +28-volt d-c line. When provided with a d-c power ground signal from the mount circuitry, the indicator remains on as long as the signal is maintained. The navigator's camera control panel is a signal unit with two electrical connectors for interconnection with the camera systems circuitry. The POWER switch must be in the READY or OPERATE position before any component of the navigator's control panel can be energized.

Table 10-1.—Capabilities and limitations of still picture camera control systems.

Subject	Capabilities and limitations
Altitude	Capable of operating within the altitude range of the aircraft.
Temperature	-54° C (-65° F) to 101° C (215° F)
Vg/H ratio limits	0.01 to 2.0 knots per foot
Modes of operation	Pulse mode Autocycle mode (day or night)
Operation	Four cameras can be operated simultaneously or individually
Missions	Basic reconnaissance High- and low-altitude general reconnaissance Low-altitude night reconnaissance Low-altitude or beach reconnaissance Long range reconnaissance



KS-68A CAMERA SYSTEM



KS-69A CAMERA SYSTEM

PH.512

Figure 10-11.—Operating envelope, KS-68A and KS-69A camera systems.

CAPABILITIES AND LIMITATIONS

The operational capabilities and limitations of the still picture camera control systems are shown in table 10-1. The limitations and capabilities of the panoramic cameras cannot be shown in this type of table but are shown as operating envelopes in figure 10-11.

The KS-68A (3-inch panoramic camera system) is used for low-altitude, high Vg/H photography and the KS-69A (18-inch panoramic camera system) is used for high-altitude, low Vg/H photography. For complete operating characteristics (parameters) on the KS-68A and KS-69A camera systems refer to section II of NavAir 01-60ABC-2-10.1.1, Aerial Photographic Systems, Camera Systems, Aircraft, Panoramic KS-68A and KS-69A.

CHAPTER 11

AIRBORNE PHOTOGRAPHIC MISSIONS

Since the beginning of time when individuals banded together for protection against an enemy, the necessity of obtaining information about the enemy has been recognized. This was found to be essential for a state of preparedness. It was soon evident that information about a nearby enemy could be gained more quickly by observers on some high place overlooking the countryside. In fact, the possession of high points of vantage often determine victory or defeat. Today the situation is basically the same, with reconnaissance aircraft securing the information concerning enemy activity and strength.

Modern aerial reconnaissance is an outgrowth of observation aviation which was the primary mission of the Army and Navy air arms during World War I. During the period between World War I and World War II the Navy made rapid strides in the development of aerial photographic techniques. These techniques were used for the photographing of gunnery exercises, mapmaking, identification of specific targets and areas, and other missions too numerous to mention for the use of the Navy Department.

During World War II, the technique of aerial photography was developed to a fine art. It is estimated that 90 percent of the intelligence derived from the enemy was gained through the use of aerial and ground photography.

Since World War II the Navy has continued to improve its photographic reconnaissance capability with the development of aerial cameras having improved optics, higher recycle rates, and image motion compensation. These cameras have been mounted in high performance jet aircraft which serve as camera platforms. Keeping pace with these improvements has been the development of high-speed processors and printers and automated photo interpretation readout equipment. This improved equipment makes it possible for fleet commanders to have intelligence information with a high order of accuracy in a very short time.

PHOTOGRAPHER'S MATES ROLE

With the advent of high performance reconnaissance aircraft and automated camera systems, the need for Photographer's Mates as members of aircraft crews has diminished.

Although the role of Photographer's Mates in the air as crewmen has decreased considerably, the need for highly qualified personnel to provide the ground support of highly complex airborne photographic systems has increased by enormous proportions. Present day reconnaissance systems require Photographer's Mates qualified in electronic camera control processing techniques.

AERIAL PHOTOGRAPHIC DEFINITIONS

There are many aerial photographic terms which you should understand in order to communicate with personnel involved in the exposing of aerial photographs; the processing and printing of aerial photography; and the interpreting of aerial photographic data. Some of these terms are discussed in the following paragraphs:

1. Aerial photography.--An aerial photograph is a photographic reproduction (of an object or a source of radiation on the earth's surface) exposed in an airborne vehicle. It is also a recording made on film from an aircraft of an object on the ground. This term is not construed to cover a photograph made air to air. This is termed an air to air photograph. The term aerial photography does, however, cover photographs of objects on the ground made from the air by both direct and indirect methods. Visual photo-

graphs and infrared photographs are obtained by direct methods; radarscope photographs, thermal photographs, and video photographs are obtained by indirect methods.

2. Aerial reconnaissance.–Aerial reconnaissance is undertaken with an aircraft to secure information about the enemy, the terrain, or the weather by visual observation, aerial photography, or electronic methods.

3. Axis of tilt.–The axis of tilt is a line representing the intersection between the tilted or oblique plane of the photographing camera and the assumed vertical plane of the same camera.

4. Convergent photography.–This is twin low-oblique photography taken with twin cameras aimed forward and backward along the flight line. (A stereoscopic overlap of 100 percent is obtained between the forward-looking photograph at the first exposure station and the backward-looking photograph at the second station).

5. Crab.–Crab is the deviation of offset of an aerial photograph with respect to the line of flight. (Crab is caused by turning the aircraft partly into the wind to offset sideward movement or drift and then not making appropriate compensation by turning the camera a like amount in the opposite direction.)

6. Datum plane.–The datum plane is the plane or level reference surface in relation to which altitudes, contour lines, or the flight altitudes for photographs are calculated.

7. Diapositive.–A diapositive is a positive photographic image on a transparent base.

8. Fiducial mark.–A fiducial mark is any marker built into an aerial camera, that registers its image on an aerial photograph as a fixed reference mark.

The image cast on a photograph by such a marker is also termed a fiducial or collimating mark. (A fiducial mark may appear in each corner of a photograph, in the center of each margin of a photograph, or may indicate the principal point of the photograph.)

9. Flight altitude.–The flight altitude is the vertical distance of an aircraft above a given datum plane, in flight, or during a specified portion of the flight.

10. Camera depression angle.–Camera depression angle is the angle, measured from the horizontal of the axis of an oblique aerial camera.

11. Camera station.–A camera station is the aircraft position or station occupied either by a photographer or by an aerial camera, depending upon the type of equipment used. In technical terms it is the point in space occupied by the camera at the moment of film exposure.

12. Cartographic photography.–A cartographic photograph is a photograph, especially an aerial photograph, obtained for, or used for, the making of a map or chart. (Cartographic photographs are usually obtained by special photographic missions but sometimes in conjunction with combat reconnaissance missions.)

13. Controlled mosaic.–A controlled mosaic is a mosaic fitted to a control plot, using photographs which have been rectified and ratioed to compensate for scale variations resulting from changes in flight altitude and camera tip or tilt.

14. Continuous strip camera.–A continuous strip camera is an aerial camera designed for taking an unbroken still photograph of a strip of terrain on a roll of film. The continuous strip camera has (instead of a shutter) a slit which remains open as the film moves past it. The speed of the film is governed by the groundspeed of the photographic aircraft, the focal length of the lens, the altitude of the aircraft, and the level of the area being photographed.

15. Flight line.–A flight line is a prescribed path in space along which an aircraft flies during the execution of an aerial-photographic mission.

16. Flight map.–A flight map is a map used as a guide in taking aerial photographs. (Flight lines drawn on a flight map guide the pilot of the aircraft through the proper paths in space to photograph the desired area.)

17. Gap.–A gap is any space where aerial photographs fail to meet minimum coverage requirements. This might mean a space not covered by any photograph or a space without minimum specified overlap.

18. Ground nadir.–The ground nadir is the point on the ground vertically beneath the perspective center of the camera lens.

19. Groundspeed.–Groundspeed is the speed of the aircraft measured by the distance it travels over the ground either by reference to check-points on the ground or by the resultant

or airspeed and wind velocity. (Groundspeed differs from airspeed in proportion to favorable or unfavorable winds. In a headwind, for example, groundspeed will be less than airspeed.)

20. High-oblique photographs.—A high oblique photograph is an aerial oblique photograph taken at such an angle that the horizon is shown.

21. Holiday.—A holiday is any space where aerial photographs have failed to cover the ground area desired.

22. Image motion compensation (IMC).—Image motion compensation is the process of synchronizing the ground image with the aircraft's forward motion during film exposure. When IMC is correct, the film moves across the focal plane of the camera at the same speed that the image (formed by the camera lens) moves across the focal plane of the camera.

23. Laser reconnaissance photography.—Laser reconnaissance systems use the linescan principle developed for high resolution radar (HRR) and infrared (IR) systems.

There are distinct advantages and disadvantages to a laser reconnaissance system. The main advantages are its high speed nighttime capability due to its being an active, narrow spectral band, linescan device. Although it is an active system, the narrowness of the laser beam and the speed of the scan make it almost completely undetectable to a ground observer.

Laser can eliminate many disadvantages of night photography such as limited area coverage; navigational difficulties; a limited number of illuminants; and ease of detection from the ground. However, there are also disadvantages to the system, the primary ones being its very poor weather penetrability, and its inability to operate at high altitudes.

Lasers are electro-optical recording sensors, not light recording cameras. Visible frequency energy is beamed to the ground and reflected back to the laser system. This reflected optical energy is sent to a photomultiplier and there converted into electronic impulses. These electronic impulses can then be amplified, recorded as a video signal and handled with electronic techniques and devices. Energy from a continuous wave laser gun is sent through an optical system. (See fig. 11-1.)

The optical system sends 10 percent of the signal to a modulator device and 90 percent of the signal to a multisided scanner. The scanner sends the beam of energy to the target. The speed of the scanner is automatically synchronized with the forward motion of the aircraft which enables a series of contiguous linescans to view the ground beneath the aircraft, perpendicular to the line of flight. The reflected energy, which is proportional to the reflectivity of the target, is collected through a receiver aperture and fed to a photo-multiplier. The resultant video signal is amplified, processed through various stages, and finally used to monitor the original 10 percent of the laser signal which is used to record the film. The film is moved at the correct V/H ratio to provide a true picture of the surveyed ground area.

The laser linescan system, although it has many of the characteristics of photography, is more like a high resolution radar set than a conventional camera system. An active light source bounces from the target. The intensity of the return is sensed by the system, amplified, processed, and recorded on film. The original signal has an optical (light) frequency. It is reflected as light, converted into electronic energy, then reconverted to light before being recorded on film.

A laser device is normally an active, rapidly moving spot scanner which produces an intensity modulated signal. This signal is proportional to the amount of light reflected from the target at any given moment. A laser device is not a super light source designed to illuminate the target for a normal camera. The laser linescan illuminates one spot at a time, almost completely eliminating obliquity (the scanner views approximately 20 degrees on either side of nadir) and shadows. As with conventional photography laser beams are severely attenuated by certain atmospheric constituents (particularly water vapor). Heavy clouds or industrial smog will almost completely diffuse the beam, and very thin clouds and haze cause a complete loss of resolution. Therefore, even with its many advantages, laser does not at the present time provide an all-weather reconnaissance capability.

24. Low-oblique photography.—Aerial photography taken at a relatively small angle from

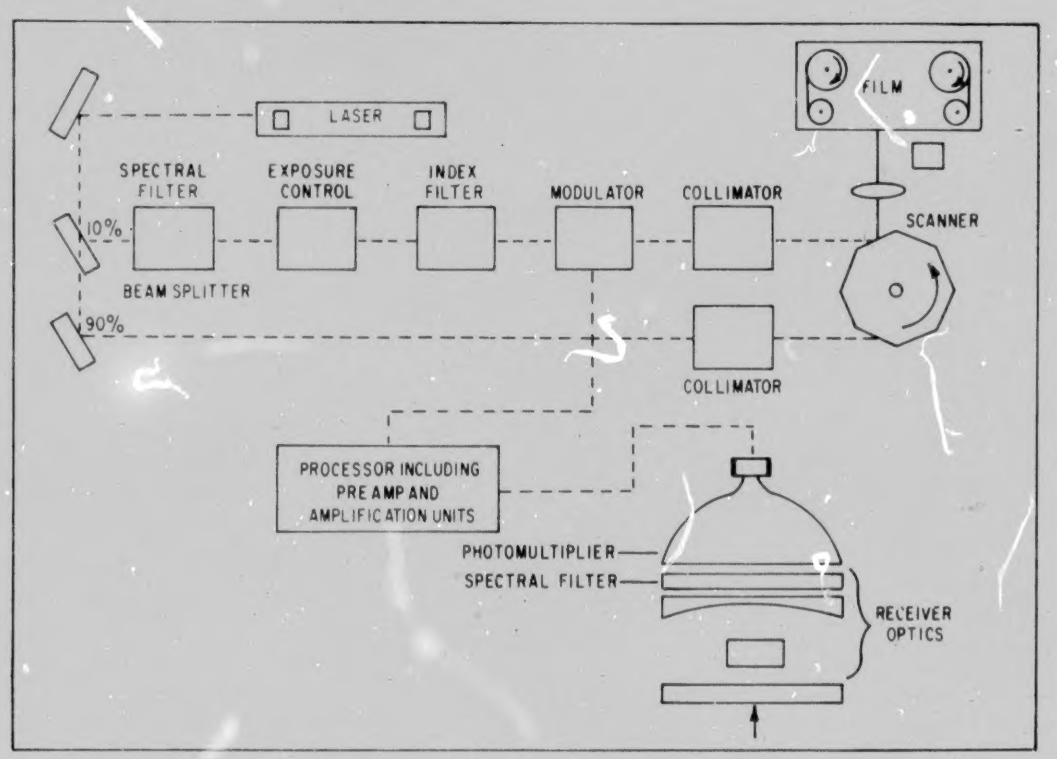

LASER
FILM
SPECTRAL FILTER
EXPOSURE CONTROL
INDEX FILTER
MODULATOR
COLLIMATOR
SCANNER
10%
BEAM SPLITTER
90%
COLLIMATOR
PROCESSOR INCLUDING PRE AMP AND AMPLIFICATION UNITS
PHOTOMULTIPLIER
SPECTRAL FILTER
RECEIVER OPTICS

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Figure 11-1.–Linescan laser component block diagram.

the vertical, especially an angle in which the horizon is not shown.

25. Mosaic.–A patchwork assembly of two or more aerial photographs, usually verticals, to provide a continuous picture. A map made from such a continuous picture is also termed a mosaic.

26. Mosaic strip.–A mosaic consisting of one strip of aerial photographs taken on a single flight.

27. Multisensor reconnaissance systems.–An aerial reconnaissance system which includes all or any combination of the following systems: optical photography; side looking airborne radar (SLAR); infrared; and laser. Multisensor systems are the result of recent developments toward the ideal reconnaissance system. The ideal system should have all of the following basic capabilities:

a. It must be able to perform in all weather conditions.

b. It must be able to perform both during the day and night.

c. It must be able to provide the location and identification of all types of targets.

d. It must present information in a format which can be easily seen and quickly analyzed.

e. It must provide extensive area coverage at all altitudes.

Conventional photographic systems do not meet all the criteria for an ideal reconnaissance system. These systems lack an all-weather capability and have limited night capabilities. However at the present time optical or conventional photography provides the best ground resolution and for this reason conventional photographic coverage is essential for detailed interpretation and analysis with other systems. The use of a combination rather than just one sensor is essential to combine all of the advantages of the sensors and will result in a greater amount of better quality intelligence.

Side looking airborne radar (SLAR) records the reflections of radiation in the microwave region of the spectrum. This sensor has the best weather penetration and range but also the poorest ground resolution of all multisensor systems.

Infrared imagery is a record of the natural emitted electromagnetic energy in shorter wavelengths than radar energy. Infrared has the best night capability of all multisensor systems; however, it has poorer weather penetration capability than SLAR.

Laser images are produced by transmitting visible frequency energy to the ground and recording its reflections. The main advantages of laser are high-speed, low-level, night time capabilities; its disadvantages are poor weather penetration capability and inability to operate at high levels.

28. Nadir point.–That point at which a vertical line through the perspective center of the lens pierces the plane of the photograph. This is also termed the photographic nadir.

29. Oblique aerial photography.–Oblique photographs of the earth's surface are taken with the camera's axis at an oblique angle to the plane of the horizon.

30. Overlap.–That part of a photograph in a reconnaissance strip or cartographic photography that covers the same area that was covered by the photograph preceding it, following it, or adjacent to it. (Forward overlap, or longitudinal overlap, is the amount by which successive photographs overlap in the direction of flight. Lateral overlap, or sidelap, is the amount by which adjacent flight line photographs overlap.)

31. Panoramic aerial photography.–Aerial photography in which a strip of the earth's surface is portrayed as a continuous photograph. It usually covers the terrain from horizon to horizon. The panoramic may be the result of joining several different photographs which have been taken at various camera depression angles or the result of special panoramic cameras designed to provide panoramic coverage.

32. Photographic Index.–A photo index or index map is a map, or chart, having outlines that indicate the areas covered by a set of aerial photographs, annotated with pertinent information and used primarily to facilitate reference to the photographs.

33. Photographic sortie.–One flight by one aircraft for the purpose of accomplishing aerial photography.

34. Photomap.–A map produced from vertical photographs, or a mosaic upon which grid lines, place names, a legend, etc., have been placed.

35. Photoreconnaissance.–Aerial reconnaissance during which information is gathered by taking aerial photographs.

36. Pinpoint photography.–A vertical aerial photograph that includes a pinpoint target.

37. Pinpoint target.–A small, precisely defined target.

38. Poststrike photography.–Photographs taken to gather information that is used in determining the efficiency of a strike.

39. Prestrike photography.–Photographs taken for the purpose of obtaining information about known targets for use by the strike force.

40. Principal point.–The center point or the center of a photograph.

41. Radarscope photography.–A photograph of a radarscope display, especially of a display on the scope of an airborne plan position indicator (PPI).

42. Reconnaissance.–An examination or observation of an area, territory, or airspace, usually from the air, either visually or with the aid of photography or electronic devices, to secure information regarding the terrain, the strength and disposition of enemy troops, enemy resources, or activities, the location and layout of targets such as enemy installations and strong points, the result of friendly air and other operations against the enemy, the disposition and condition of friendly troops, the weather, or any other information regarding the situation, usually in a combat area or in enemy territory.

43. Reconnaissance strip.–A series of overlapping aerial photographs taken along a single line of flight for reconnaissance purposes.

44. Rectification.–The process of projecting a tilted or oblique photograph onto a horizontal reference plane, the angular relation between the photograph and the reference plane being determined by ground reconnaissance. Transforma-

tion is the special process of rectifying the oblique images from a multiple lens camera to equivalent vertical images by projection onto a plane that is perpendicular to the camera axis. In this situation the projection is onto a plane determined by the angular relations of the camera axis and not necessarily onto a horizontal plane.

45. Semicontrolled mosaic.–A mosaic composed of uncorrected vertical aerial photographs laid to limited ground control.

46. Side looking radar presentation.–A filmstrip recording which visually displays the electromagnetic energy returns from the terrain under both sides of the aircraft. In operation the side looking aerial radar (SLAR) transmits and receives electromagnetic energy along a radial path perpendicular to the direction of flight. The motion of the aircraft provides the scanning or coverage along the line of flight and, in this respect, the side looking radar presentation is analogous to continuous strip photography.

The capabilities of SLAR make it a useful all weather day and night mapping and reconnaissance sensor. SLAR is termed "side looking" because it transmits the radar beam in a fixed direction at approximately right angles to the longitudinal axis of the aircraft. Thus the radar antennas look to the sides of the aircraft. The forward motion causes successive transmitted beams to cover new areas. By contiguous line-scans a composite coverage of a wide area of terrain is obtained.

47. Split cameras.–The term split camera is applied to an assembly of two cameras systematically disposed at a fixed angle relative to each other so as to provide extended lateral coverage.

48. Split-vertical photographs.–A photograph made from the negative of two aerial cameras arranged side by side and taking vertical photographs simultaneously to provide wider coverage.

49. Stereo pair.–A pair of photographs (especially photographs of the same subject) which create a 3-dimensional illusion when properly arranged and viewed together. Each photograph of a stereo pair is taken from a slightly different position; this provides a large percentage of overlap. A stereoscope is normally used for viewing stereo pairs.

50. Strike photography.–Photography made of a strike while the strike is in progress. Strike photography is used for purposes of critique.

51. Thermal photography.–Photography made of an image tube or similar device that shows objects on the earth differentiated by their radiations of heat or infrared waves.

52. Tilt.–Tilt is sometimes referred to as lateral shift. It is the inclination of an aerial camera from the vertical and perpendicular to the direction of flight. Tilt can be measured by the angle between the camera axis and a plumbline dropped from the optical center. Tilt is also the projection of this inclination to the photo taken.

53. Tip.–The inclination of an aerial camera in the direction of flight.

54. Transverse photography.–Also termed twin low-oblique photography. Transverse photography is taken with twin cameras at right angles to the line of flight. One a left looking camera the other a right looking camera expose two different pictures simultaneously. The individual cameras are tilted so that their optical axis make an intended angle of 20 degrees with the vertical and 40 degrees with one another. The resulting left looking and right looking photographs will overlap each other by approximately 60 percent.

55. Trimetrogon photography.–A method of aerial photography whereby three photographs are taken simultaneously–one vertical and two high obliques–in a direction at right angles to the line of flight. The obliques are taken at an angle of 60 degrees from the vertical and sidelap the vertical photograph. This provides coverage of the earth's terrain from horizon to horizon with overlap in the line of flight.

56. Uncontrolled mosaic.–A mosaic composed of uncorrected (not rectified) photographs in which detail has been matched from print to print without ground control or other orientation.

57. Vertical photography.–Aerial photography taken with the axis of the camera in a vertical position. A maximum of 3 degrees tilt is permitted in a vertical photograph.

58. Video photography.–Photography made from the images displayed on a television screen.

59. Visual photography.—Also termed conventional and optical photography. A photograph taken directly of an object that can be seen by the human eye. It is taken without the benefit of infrared, side looking air borne radar (SLAR), or lasers.

AERIAL PHOTOGRAPHIC MISSIONS

The Photographer's Mate will find that there are numerous factors involved in the planning of an aerial photographic mission. The type of mission, the selection of equipment, and the amount of expendable material required play an important part in the successful planning of an aerial photographic mission. Also, wartime or peacetime will determine to a great extent the amount of planning needed. In addition to the factors listed above, wartime factors of enemy opposition, time over the target area, number of aircraft available, and weather conditions are definite influences in the planning of an aerial photographic mission.

MISSION PLANNING

The ultimate success of any aerial photographic mission is largely determined by the accuracy and thoroughness of premission planning and the degree of crew coordination.

Operational considerations of the mission are usually determined by a higher level planning team than the reconnaissance crew. These considerations are as follows:

1. Type and location of target.
2. Enemy defenses affecting the successful accomplishment of the mission.
3. Weather.
4. Photographic capability and range of the aircraft.

Type and Location of Target

The type and location of the target to be photographed are often the determining factors in deciding the unit or type of aircraft that will perform the photography. Targets located deep in enemy territory generally require the use of fast, high-flying, long-range reconnaissance aircraft. Generally, targets such as pinpoints, strips, areas close to the front, and beach defenses will require photography at extremely low altitudes and high speed, and will make use of the reconnaissance fighter aircraft, such as the RF-8G and RA-5C.

Enemy Defenses

Consideration of enemy defense in the air, on the ground, and at sea is of vital importance in mission planning. Reconnaissance aircraft must return safely to base with the desired photography if the mission is to be successful. Consequently, the most careful attention must be given to the routes to and from the target, and to the selection of altitudes while en route and when directly over the target. The possibilities of radar detection and fighter interception must be weighed and evaluated. If intelligence information or experience indicates that enemy opposition is too strong for the reconnaissance attack aircraft, a reconnaissance fighter must be employed (possibly in coordination with fighter screening or diversionary tactics) to draw off the enemy interceptors. As an alternative to this, the mission may be flown at night, accepting possible reduction in quality and quantity of photography imposed by the use of artificial illumination.

Weather

Weather is probably the greatest single limiting factor in reconnaissance operations. Although considerable research and experimentation have been conducted with infrared film, filters of various types, radarscope photography, and similar devices, there is still no proven method for getting good interpretable photography through clouds or fog.

Target conditions are often such that satisfactory photography cannot be accomplished, particularly in regard to scale requirements. Furthermore, an aircraft operating at low levels because of low ceilings and poor visibility becomes increasingly vulnerable to enemy antiaircraft fire. The camera field also is greatly reduced at low altitude, thereby jeopardizing complete target coverage. Shutter speeds and aperture settings also may be a factor in poor photography in this case, though modern aerial cameras have overcome this to a great extent with the refined camera control systems. Sometimes, however, though the weather may be bad en route to the target, the target area proper may remain clear. Under these conditions the reconnaissance aircraft can take advantage of the cloud cover en route to gain concealment from the enemy fighters and still be able to obtain photographic coverage of the target. Thus, weather sometimes can prove to be a friend to reconnaissance rather than an enemy.

Capability and Range of Aircraft

Photographic capability of the aircraft to be employed must be taken into consideration during mission planning. Two major considerations limit the effectiveness of the reconnaissance aircraft in daylight operations. First, if cameras are not accessible in flight to permit changing camera settings and magazines, the number of photographs that can be taken per mission is limited. For this reason coverage of a large area requires more sorties when flown by aircraft without access to the cameras during flight.

Day reconnaissance aircraft are extremely versatile in performing photographic missions. They have a diversified camera array which permits taking oblique and vertical photographs at any altitude.

When planning a night mission, consideration must be given to the capability of the camera, the illuminant, and the number of illuminants to be carried within the aircraft.

MAPS AND CHARTS

A map or chart of the area to be photographed, if available, is quite important in the successful accomplishment of an aerial photographic mission. The Photographer's Mate should be familiar with the different types of maps and charts available to him and the grid coordinates which allow the definite location of points.

A map, chart, aeronautical chart, or hydrographic chart is defined as a graphic representation of the earth or a portion of the earth, drawn to scale and projected on a plane.

A map is used primarily for land navigation, while a chart is used primarily for water navigation. Depicted on a map or chart are the essential topographic features, water depths, roads, railroads, rivers, lakes, towns, cities, airfields, and manmade objects. The number and kind of these features depend upon the primary use of the map or chart.

Aeronautical charts are printed with the essential topographic features and have, in addition, aids to aerial navigation. Some of the aids would be: Air Defense Identification Zones, Airways, Air Tower frequencies, Restricted Areas, and others which help the Aerial Navigator.

Hydrographic charts are special water navigation charts with only the essential topographic and cultural features of the particular area depicted. Emphasis is on the water area, where waterways, water depths, and water navigation hazards and aids are shown.

To locate a point on the earth's surface, several military grid systems and geographic coordinates are used.

TYPES APPLICABLE TO PHOTOGRAPHIC MISSIONS

There are various types of maps and charts available to the Photographer's Mate for use in aerial photographic missions. Flight lines will be drawn on the best map available of the area to be photographed. Aeronautical charts, standard Geological Survey maps, index maps of previous photography, county maps reduced to appropriate scale, forestry maps, or maps made by local authorities, such as roadmaps, etc., will serve the purpose. The scale of the chart is largely a matter of personal choice and the result of availability. The map/chart is an important factor in securing the best possible photographic reproduction of the area. It should have the flight lines in their exact position in relation to the ground and drawn with a fine point pen so as not to obstruct possible vital checkpoints, then redrawn over the thin line with a colored marking pen other than black (such as red, orange, yellow, etc.) so that the line density does not obliterate information under the line.

As an aid to the photo pilot or navigator, the flight lines should be extended beyond the camera-on-off position to allow ample run-in time for the pilot to adjust flight path and to place the aircraft at the required altitude and attitude over the flight line prior to the first exposure.

Evaluation

An evaluation of a map to determine its accuracy and currency will aid in the proper choice between two or more maps available for plotting. When only one map or chart is available, this evaluation will assist the pilot or navigator to determine the reliability of various features of presentation. In general, manmade features such as houses, factories, built-up cities, bridges, and roads will make greater and more rapid changes than natural features of terrain and vegetation. Among the more important items to be considered in evaluating a map are the following:

1. DATES. One or more dates, with various meanings, may be found on maps.

a. "Date of survey" indicates the time the essential data were obtained by actual survey.

b. "Date of revision" is the best indication of how current the map is if the extent of revision is indicated. Even though landforms change slowly, a map survey in the nineteenth century may not give a true picture of the terrain as it now exists. Urban and industrial areas are particularly subject to change. The extent or revision may or may not be indicated in the marginal information.

c. "Date of compilation" indicates when map data were collected, but does not show if the information is up to date. However, the dates of the sources from which the map was compiled are very significant.

d. "Date of publication" is the date most commonly found on maps. It indicates only the time the map was made available for general use.

e. "Date of reprint" refers to the time a map was reprinted from previously used plates. It does not signify that changes were made on the map.

2. PUBLISHING AGENCY. The type of agency responsible for preparing a map is a guide to its reliability. Maps published by governmental or military agencies are generally the most reliable. Private agencies produce excellent maps, but these are frequently of such general nature that they lack the specific detail needed for vertical aerial photography.

3. COMPOSITION. The composition of a map is usually another key to its reliability. Proper location of place names and symbols, the detail with which the coastline (if present) is represented, careful use of color, and other items of draftsmanship indicate the care used in preparing maps.

4. MISCELLANEOUS MARGINAL INFORMATION. In addition to indicating accuracy and currency, marginal information may show the names of adjoining sheets and a geographic orientation diagram. Included in the marginal information of most United States maps is a legend identifying symbols used, a glossary of foreign words, and a diagram showing true, grid, and magnetic north.

SELECTION OF EQUIPMENT

CAMERAS

In selecting the proper type of camera (or cameras) for a photographic mission, various factors are involved. The scale of the completed photography, the types of cameras available, the type of aircraft available, and its photographic capabilities (such as type of camera installations, number and types of cameras which can be mounted in the aircraft and its speed and altitude limitations), all play an important part.

The major types of aerial cameras available are described in chapter 8 of this training manual and chapter 20 of the PH 3 and 2 rate training manual, NAVPERS 10355-A. Refer to these chapters and to the Navy Stock List of the Aviation Supply Office, section WEL0068 (Series) for a complete listing of all aerial cameras available.

MAGAZINES

The type of mission dictates the choice of magazine to use. If it is a high-altitude mission, normally a standard magazine with sufficient film capacity to record the required number of exposures will suffice.

MOUNTS

Various types of mounts are available for different types of aerial photography. In fighter-photo aircraft the fixed vertical mount, the rotatable mount, the trimetrogon, and the fixed oblique and forward firing mount are available.

In the larger photographic aircraft, besides the ones listed above, the gyrostabilized mount is available. Obviously, the type of mission will dictate the type of mount required. Various types of mounts are described in chapter 9 of this training manual.

TYPE AND AMOUNT OF EXPENDABLE MATERIAL

The Photographer's Mate is normally responsible for computing the amount and type of film to be used on an aerial photographic mission. The time of day, the weather, and other considerations are involved in figuring out the type of film to use. The type of mission, the scale of the finished photography, and the size of the area to be photographed dictate the amount of film which is required to complete the mission successfully.

For the formulas involved in computing the amount of film required for an aerial photographic mission, refer to chapter 21 of Photographer's Mate 3 & 2, "Aerial Photography."

In computing the amount of photographic paper required to print the exposed and developed negatives, the requesting activity specifies the number of prints per exposure required. Add 10 percent to this for test strips and waste and a reasonably accurate figure is determined.

PROCESSING SUPERVISION

The Photographer's Mate in charge of the various sections in the photographic laboratory has certain responsibilities in connection with his work. The most important of these are discussed below.

DEVELOPING

The Photographer's Mate charged with the supervision of the developing of aerial photographic film should make certain that all the equipment is in satisfactory working order, fresh developing and fixing solutions (of the proper type) are available at all times, and that the personnel working under him are thoroughly indoctrinated in the film developing process. He also has to insure that they are capable of using all the equipment available within the developing section. The Photographer's Mate should also have a satisfactory system working so that when film is delivered to the developing section for processing, it progresses through the section with a steady flow, and is not held up during the process. He should have a system set up so that all priority work is accomplished as soon as possible, and all routine work is processed without undue delay.

DRYING

The drying of aerial film is one of the most important steps in the processing cycle. Improper drying can ruin an otherwise perfect roll of aerial film. The Photographer's Mate in charge of this operation should be completely familiar with the aerial film dryers used in his section, and know what to do if the equipment fails. He should instruct the personnel working for him in the proper use of the equipment and he should supervise the proper preventive maintenance on the equipment. For information on the operation and service of the various types of aerial film dryers in use in the Navy, refer to their operation and service manuals, which are to be found in the technical library of every photographic laboratory.

AERIAL RECONNAISSANCE MOBILE PHOTOGRAPHIC LABORATORIES

With the aid of Mobile Photographic Trailers, the Heavy Photographic Squadrons have been able to provide rapid film processing and immediate photographic evaluation/interpretation in the field to Fleet Commanders and other requesters.

TYPE ES-40A MOBILE PHOTOGRAPHIC LABORATORY

The ES-40A laboratory consists of three trailers, two processing trailers, and one administration trailer. It is transportable by air and may be broken down into component units for field operations as needed. Three generators, three air-conditioning units, and the running gear necessary to transport the above equipment are also provided. The laboratory provides the means for processing, annotating, and printing aerial reconnaissance films in 16mm, 70mm, 5-inch, and 9 1/2-inch widths and lengths up to 500 feet. The two EH-38C processing machines supplied with the unit are complete with 25-gallon chemical mix tanks each for replenishment. Other equipment includes two EN-6A printers, EN-46B, EN-80A and EN-52A printer, FN-8A easel, AR-6 viewing table, and a Friden Flexowriter Titler. Revisions have been made to include a Kodak Densitometer Model 1 and Sensitometer Model 101 with shock mounting pads. For further information, consult Naval Photographic Center Research and Development Project No. WEPTASK FFRD 00002/214 2/F001 04 003, amendment No. 136, dated 12 Oct 1965.

TYPE ES-81A MOBILE PHOTOGRAPHIC LABORATORY

The ES-81A Photographic Laboratory, Mobile, Aerial Reconnaissance, Color Film Unit is supplied complete with an EN-6A printer, one densitometer, two hydro-mixers, one portable mixer, one AR-6A viewing table, and one EH-73A Color Processor Model 1411A-M, which is designed for rapid processing and drying of certain Kodak Ektachrome aerial rollfilms up to 9 1/2 inches wide. Eight 30-gallon replenisher tanks with the Chemical Control Assembly Unit are provided. Normal machine operating speed is 3.2 feet per minute for all recommended films. First developer temperature is variable for forced processing (106° ± 1/2° F) for double camera speed. The film will shift somewhat in color balance and contrast and will have lower maximum density. Two trailers are used for the ES-81A unit.

CAPTIONING

The proper captioning of aerial negatives is mandatory, and is accomplished as outlined in Defense Intelligence Agency Manual, DIAM 55-5. Aerial Photography and Airborne Electronic Sensor Imagery (Forwarding, Titling and Plotting). The Photographer's Mate supervising the captioning of aerial negatives should make sure that it is done properly, and that the personnel working under him are thoroughly indoctrinated in the proper method of captioning.

Aerial photography of areas outside the continental United States which is to be forwarded to the Navy Department must be indexed. The Secretary of Defense has directed the adoption of a Standard Indexing System for Aerial Photography by all armed services. Instructions covering the methods of indexing and plotting aerial photography are currently promulgated as DIA Manual, DIAM 55-5.

PRINTING

The supervisor of the printroom must insure that the personnel working under him are indoctrinated in the proper use of all the printers, enlargers, washers, and other equipment associated with the printroom. He also insures that prints of the proper contrast and density are produced, and that the proper number of prints are produced with the minimum of wastage of printing paper and chemicals. He must ascertain that sufficient chemicals of the proper type and quantity are on hand at all times, and that fresh chemicals are used when the old are exhausted.

Laboratory electronic interval timers should be checked periodically for correct operation. The shutters of ground still cameras must be checked for proper synchronization. Any corrective action taken on electronic interval timers, camera shutters, and other delicate or complicated equipment should be performed by competent repair personnel only.

RECONNAISSANCE AIRCRAFT

Presently in service with Navy reconnaissance squadrons are two types of reconnaissance aircrafts—the RF-8G and the RA-5C. Brief descriptions of these aircraft follow.

The RF-8G aircraft is a single place photographic reconnaissance version of the Crusader supersonic fighter. It is presently employed by a light photographic squadron (VFP-63), which provides 3-plane detachments to HANCOCK and MIDWAY class CVA's. This aircraft has a night photographic capability with the use of photographic flares launched from racks installed in the top of the fuselage.

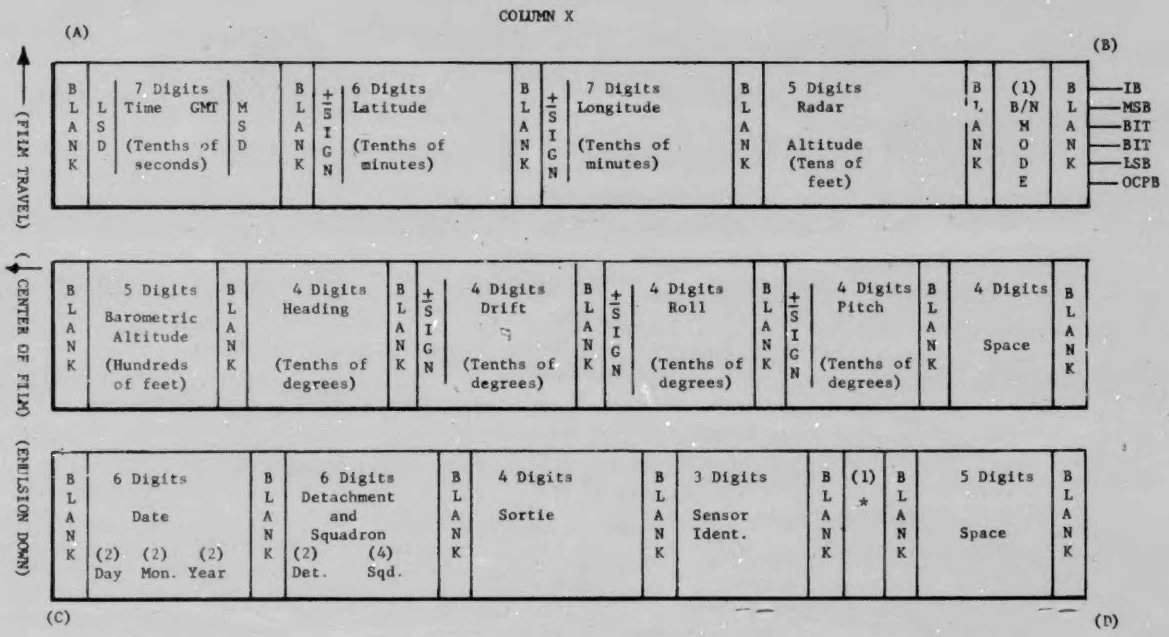
The RA-5C aircraft is a supersonic, twin-jet, 2-place carrier aircraft with a multisensor reconnaissance capability. These aircraft are assigned to heavy reconnaissance attack squadrons (RVAH) and are operated from integrated operational intelligence center (IOIC) equipped FORRESTAL (CVA-59) class attack carriers.

The aircraft and its systems comprise one-half of the U.S. Navy Integrated Operational Intelligence System (IOIS). The airborne system's counterpart is the ship- or ground-based Integrated Operational Intelligence Center (IOIC). The system is designed to provide tactical commanders with the full and up-to-the-minute intelligence picture on any target area. This information is composed of photographic coverage, infrared detection coverage, radar coverage, and Electronic Order of Battle (EOB) data.

This aircraft is the Navy's first true multisensor vehicle. In addition to framing and panoramic cameras, the aircraft has side-looking radar, which records (Photographically) reflected microwave energy rather than reflected light, an infrared detection set which also records on photographic film, the infrared radiations coming from the terrain under investigation, and other sensors of an electronic nature. A night capability is provided through the use of wing-mounted electronic flasher pods.

Inputs from the aircraft's navigation system provide positioning data, altitude, and other essential information which appear in a binary coded form on a data block. This coded information is recorded with the imagery on all sensors (fig. 11-2). With some practice this information can be decoded using the key illustrated in figures 11-3 and 11-4.

By use of code matrix readers in the stereo comparative viewers installed in the IOIC, specific frames of film can be automatically retrieved by geographical coordinates. Direct measurements can then be made from it through

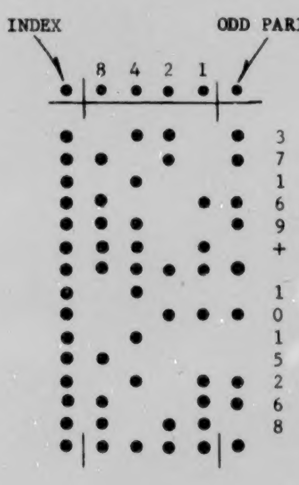

COLUMN X
(A)
(B)
(C)
(D)
(FILM TRAVEL)
CENTER OF FILM
(EMULSION DOWN)
(NEGATIVE)
BLANK
LSD
7 Digits Time GMT (Tenths of seconds)
MSD
±SIGN
6 Digits Latitude (Tenths of minutes)
7 Digits Longitude (Tenths of minutes)
5 Digits Radar Altitude (Tens of feet)
(1) B/N MODE
IB
MSB
BIT
BIT
LSB
OCPB
5 Digits Barometric Altitude (Hundreds of feet)
4 Digits Heading (Tenths of degrees)
4 Digits Drift (Tenths of degrees)
4 Digits Roll (Tenths of degrees)
4 Digits Pitch (Tenths of degrees)
4 Digits Space
6 Digits Date (2) Day (2) Mon. (2) Year
6 Digits Detachment and Squadron (2) Det. (4) Sqd.
4 Digits Sortie
3 Digits Sensor Ident.
(1) *
5 Digits Space

LEGEND:
OCPB - Odd Character Parity Bit
IB - Index Bit
LSD - Least Significant Digit
MSD - Most Significant Digit
BLANK - Excess 3 Code w/OCPB & IB as (111111)
LSB - Least Significant Bit
MSB - Most Significant Bit
SPACE - Excess 3 Code w/OCPB & IB as (100001)
* SLR Mode Switch Position or Pan Prism Ident. (Left or Right) or Space

PH.514

Figure 11-2.–Code matrix block contents.

An example of how to read latitude and time from a matrix is given below.



Read:

Latitude: + 37° 16.9'

Read:
Time: 10 hr 15 min
26.8 sec

Note: The parity bit does not appear unless the significant bits are of an even number. This provides the odd parity check to insure the bit recording is correct.

PH.515

Figure 11-3.—Code data matrix reading.

The data matrix is coded in excess three binary coded decimal. That is to say this system uses decimal numbering but it is recorded in a coded binary form as listed below. It is read as a normal binary system, that is right to left, making a summation of the bits, then subtracting three to obtain the decimal values as tabulated below.

DECIMAL	BINARY 8	4	2	1 (Bit value)
	●	●	●	●
0 - - -			●	●
1 - - -		●		
2 - - -		●		●
3 - - -		●	●	
4 - - -		●	●	●
5 - - -	●			
6 - - -	●			●
7 - - -	●		●	
8 - - -	●		●	●
9 - - -	●	●		
+ - - -	●	●		●
- - -				●

A plus or minus zero code may occur in the CMB and is an acceptable coded digit. The plus and minus code convention is as follows:

LATITUDE	+NORTH -SOUTH
LONGITUDE	+EAST -WEST
DRIFT	+AIRCRAFT NOSE LEFT OF GROUND TRACK -AIRCRAFT NOSE RIGHT OF GROUND TRACK
ROLL	+RIGHT WING DOWN -RIGHT WING UP
PITCH	+NOSE - UP -NOSE - DOWN

PH.516

Figure 11-4.—Data matrix coding.

the use of computers tied into the stereo comparative viewers. The code matrix block consequently, is one of the keys to automating the integrated operational intelligence center. Therefore, exposure of not only the film but also the cathode-ray tube, which exposes the coded data, is critical. Likewise, the processing of film, both from cameras and other sensors, requires the strictest photographic quality control.

In the integrated operational intelligence system, as in all high acuity readout systems, photographic interpretation is done from the negative or a positive transparency.

The film processing section of the center is equipped with four EH-38C Versamat Processors, a central chemical mix station, EN-6A printers, a miniature transparency (mitran) copy camera, and accessory equipment for film breakdown and handling.

The printing phase of the processing procedure is one of the most important, as the quality of the final prints is the ordering activity's major concern. The supervisor should insure that all the prints produced under his supervision are free from pinholes and dustmarks, and that they are printed on the proper type and grade of printing paper.

FINISHING

The Photographer's Mate in charge of the finishing room in a photographic laboratory insures that prints are thoroughly washed before being placed in a dryer. He also insures that the dryer is at the proper temperature, and that only the specified type of printing paper is put into the dryer—glossy prints in a glossy dryer and matte prints in a matte dryer. He insures that the proper preventive maintenance is performed on all of the equipment in the finishing room and that all personnel concerned with finishing prints are indoctrinated in the proper use of all of the equipment.

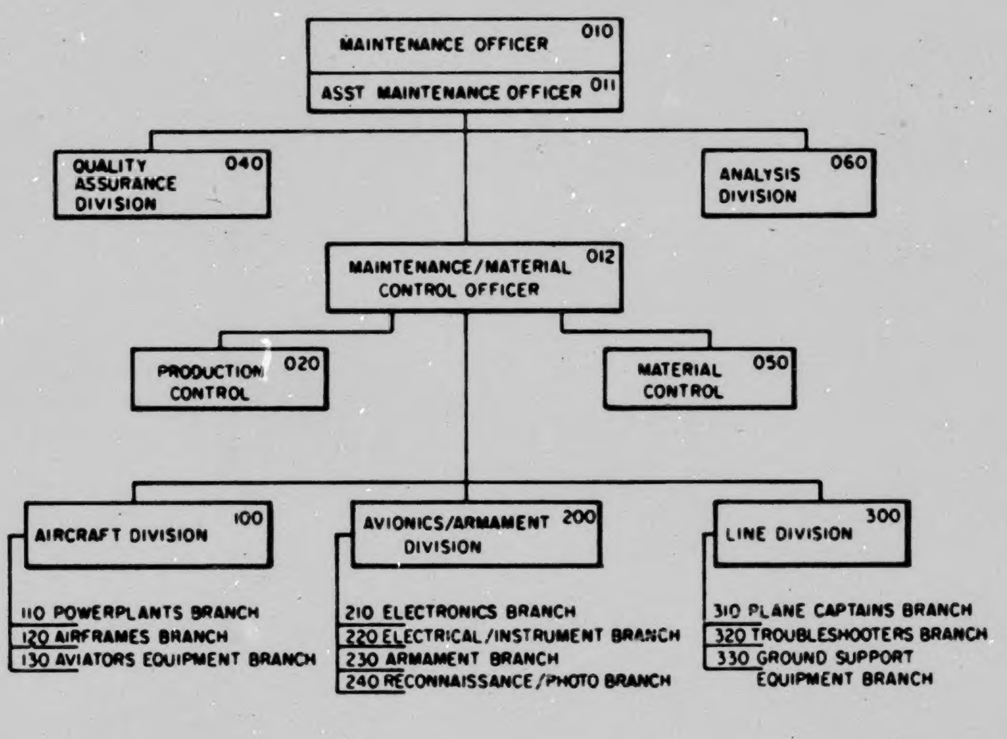
SUPERVISING FIXED INSTALLATION MISSIONS

There are two types of photographic squadrons that have the specific mission of obtaining photographic coverage of assigned targets and areas. The Photographer's Mates assigned to these squadrons must become familiar with, and supervise, the installation of various types of equipment in the particular aircraft assigned to each of these squadrons. The VFP squadron has the RF-8G type aircraft and the RVAH squadrons are equipped with the supersonic RA-5C Vigilante.

LINE CREW ORGANIZATION

In the VFP squadrons the Photographic Operations Division consists of Line Operations and Maintenance. The Photo Line Crew is charged with the responsibility of the installation of cameras, loading of magazines, preflight systems checks, unloading magazines, and marking film and placing it in containers for forwarding to the photographic laboratory for processing.

Within the RVAH organization, the Photo Line is a branch (Work Center 240) of the Avionics/Armament Division of the Maintenance Department. (See fig. 11-5.) The organization of an RVAH photo line crew must remain flexible to conform to squadron needs. Placement of


MAINTENANCE OFFICER 010
ASST MAINTENANCE OFFICER 011
QUALITY ASSURANCE DIVISION 040
ANALYSIS DIVISION 060
MAINTENANCE/MATERIAL CONTROL OFFICER 012
PRODUCTION CONTROL 020
MATERIAL CONTROL 050
AIRCRAFT DIVISION 100
AVIONICS/ARMAMENT DIVISION 200
LINE DIVISION 300
110 POWERPLANTS BRANCH
120 AIRFRAMES BRANCH
130 AVIATORS EQUIPMENT BRANCH
210 ELECTRONICS BRANCH
220 ELECTRICAL/INSTRUMENT BRANCH
230 ARMAMENT BRANCH
240 RECONNAISSANCE/PHOTO BRANCH
310 PLANE CAPTAINS BRANCH
320 TROUBLESHOOTERS BRANCH
330 GROUND SUPPORT EQUIPMENT BRANCH

PH.517

Figure 11-5.—Organizational level maintenance department organization.

Photographer's Mates must be adjusted to fit the routine of shipboard operations when deployed and station committments when shore based. All RVAH squadrons deploy as a unit while the VFP squadrons normally deploy only as detachments.

Photo Line Crew Supervisor

The Photo Line Crew supervisor should thoroughly understand the photo capabilities of the type of aircraft assigned. He should also have prior training and experience in the installation of various types of mounts and cameras, and should understand the operation of the camera control system, image motion compensation, and the viewfinder.

In naval reconnaissance photography today it is not enough that the line crew supervisor be well versed in mechanical and chemical aspects of photography. He must have at least a fundamental understanding of electronics and a working knowledge of electricty, as well as the proper use of a multimeter. The cameras and control systems used in the modern jet aircraft for reconnaissance purposes are a vast maze of electrical and transistorized electronic components which makes it imperative that all personnel assigned to service and maintain these systems have at least fundamental training in electricty, electronics, and transistors. Without this training, supervisors and other line personnel are not really qualified to work with these systems.

The supervisor of a Photo Line Crew has the responsibility of checking out his men in the following duties: To configure the aircraft with the proper cameras that fulfill the requirements of the scheduled mission; to load and install magazines and cassettes; to adjust exposure settings; to check out the camera control system as outlined on the preflight check sheet; to prepare an information card for the pilot or radar air navigator and be prepared to answer questions they may have about the installed equipment; and operation of all ground support equipment necessary to the installation and operation of the system while the aircraft is on the ground.

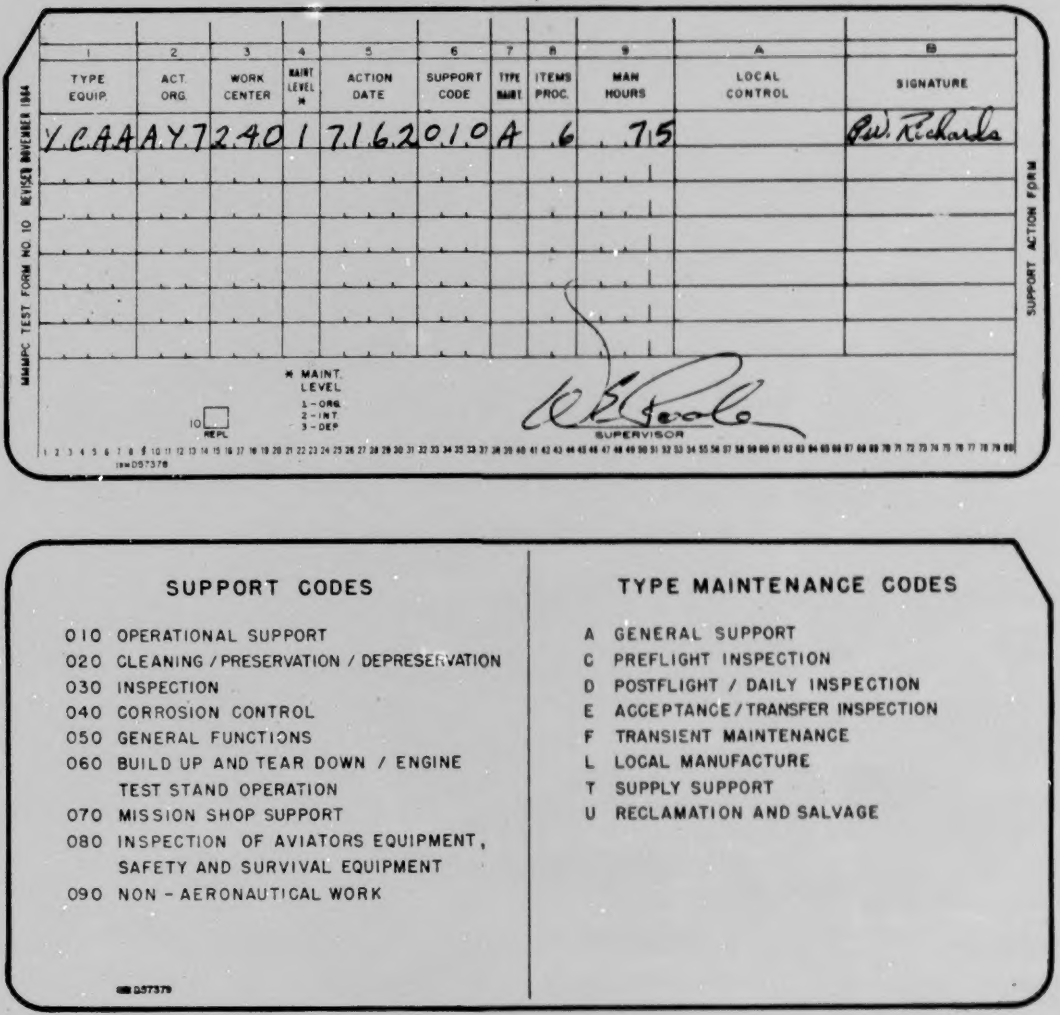
The photo line supervisor should also see that his men are properly indoctrinated in procedures of the Naval Aircraft Maintenance Program (3-M). The Maintenance and Material Management Program may seem to be only a nuisance to many of the personnel who are charged with the responsibility of the maintenance of the photographic systems in the aircraft. In reality though, the 3-M System will prove to be an aid to maintenance if properly used. To be effective, documentation of all transactions must be complete and accurate. This documentation is one of the most important duties of the Work Center Supervisor; it is his job to check all the paper work involved in each transaction for accuracy and completeness.

The operating details of the Navy Maintenance and Material Management System are covered in Military Requirements for Petty Officer 3 & 2, NavPers 10056-C, and in Military Requirements for Petty Officer 1 & C, NavPers 10057-C. However, specific information of interest to PH supervisors, relative to the Support Action Form, is presented in the following paragraphs.

Support Action Form (SAF)

The documentation procedures and separate reporting of support type data was designed so that the time expended in the accomplishment of repetitive type tasks that consume many manhours (but do not involve malfunctions, repairs, or condemnation action) may be easily identified, reported, and monitored. Manhours expended in support duties by photographers (such as installation and removal of cameras in configuration of an aircraft reconnaissance system, loading or unloading film in cameras, removal and reloading film in cassettes, or corrosion control, cleaning windows, etc.) are documented on the Support Action Form (MMMPC Test Form No. 10). (See fig. 11-6.)

The SAF is a standard Electronic Accounting Machine (EAM) card which may be either handscribed or prepunched/preprinted, depending on the desires and requirements of local maintenance managers. In either case, all support action forms will be signed by the work center supervisor to indicate that screening has been accomplished. Figure 11-6 is a sample of the handscribed form and figure 11-7 is a sample of the prepunched/preprinted form.



MMMPC TEST FORM NO 10 REVISED NOVEMBER 1964

1	2	3	4	5	6	7	8	9	A	B
TYPE EQUIP.	ACT. ORG.	WORK CENTER	MAINT LEVEL *	ACTION DATE	SUPPORT CODE	TYPE MAINT	ITEMS PROC.	MAN HOURS	LOCAL CONTROL	SIGNATURE
Y.C.A.A	A.Y.7	2.4.0	1	7.1.6.2	0.1.0	A	6	.75		P.W. Richards

10 ☐ REPL

* MAINT. LEVEL
1 – ORG.
2 – INT.
3 – DEP.

W. E. Poole
SUPERVISOR

IBM 057378

SUPPORT ACTION FORM

SUPPORT CODES

010	OPERATIONAL SUPPORT
020	CLEANING / PRESERVATION / DEPRESERVATION
030	INSPECTION
040	CORROSION CONTROL
050	GENERAL FUNCTIONS
060	BUILD UP AND TEAR DOWN / ENGINE TEST STAND OPERATION
070	MISSION SHOP SUPPORT
080	INSPECTION OF AVIATORS EQUIPMENT, SAFETY AND SURVIVAL EQUIPMENT
090	NON - AERONAUTICAL WORK

IBM 057379

TYPE MAINTENANCE CODES

A	GENERAL SUPPORT
C	PREFLIGHT INSPECTION
D	POSTFLIGHT / DAILY INSPECTION
E	ACCEPTANCE / TRANSFER INSPECTION
F	TRANSIENT MAINTENANCE
L	LOCAL MANUFACTURE
T	SUPPLY SUPPORT
U	RECLAMATION AND SALVAGE

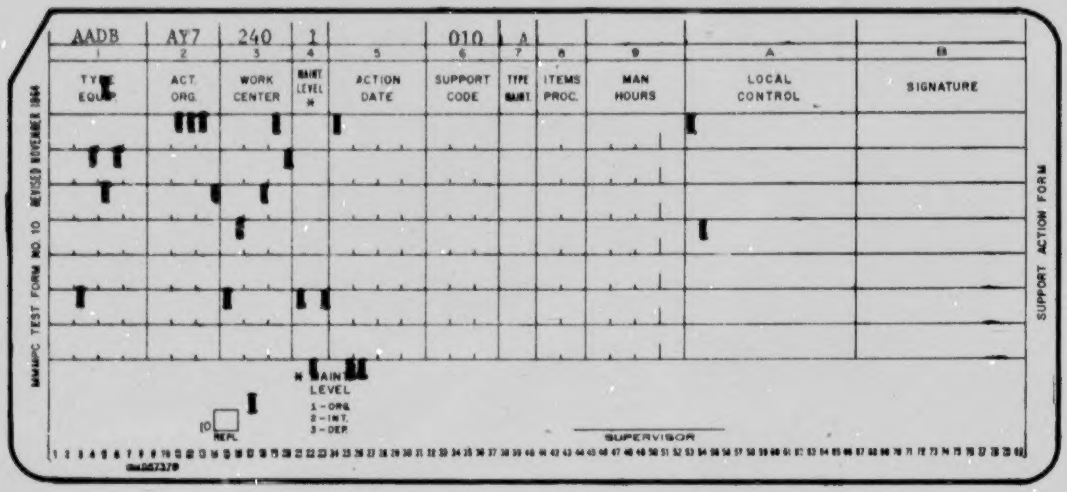
PH.518

Figure 11-6.–Handscribed Support Action Form.

In view of the fact that the major part of the photographic line crew work is not maintenance, but operational support, it would be wise to insure that all personnel in the work center understand the importance of accuracy and completeness of the SAF's. They should know where to find all the information required to fill these forms out, such as the Work Unit Code Manual and the Naval Aviation Maintenance Program.

CAMERA INSTALLATIONS

The supervisor of a photo line crew is responsible for the proper installation of cameras in the aircraft assigned so that it will be able to complete its mission properly. Various types of missions require different types of cameras in different installations within the aircraft. As an illustration of specific camera installations, the RF-8G aircraft is used.



MMMPC TEST FORM NO. 10 REVISED NOVEMBER 1964

AADB	AY7	240	1		010	A				
1	2	3	4	5	6	7	8	9	A	B
TYPE EQUIP.	ACT. ORG.	WORK CENTER	MAINT LEVEL *	ACTION DATE	SUPPORT CODE	TYPE MAINT.	ITEMS PROC.	MAN HOURS	LOCAL CONTROL	SIGNATURE

* MAINT. LEVEL
1 - ORG.
2 - INT.
3 - DEP.

10 ☐ REPL.

SUPERVISOR

SUPPORT ACTION FORM

PH.519

Figure 11-7.—Prepunched/Preprinted Support Action Form.

CAMERA STATIONS

The RF-8G has four separate camera stations (fig. 11-8). Station 1, located underneath the aircraft, forward of the nosewheel, is a forward firing station and accommodates a KA-45A or KA-51A in a fixed mount, which provides a depression angle of 15 degrees, forward oblique. Station 1 can also carry in place of the KA-45A and KA-51A still cameras either a DBM4 or DBM5C motion picture camera.

The DBM4 and DBM5 cameras are contained in fixed mounts which can be adjusted to give depression angles from approximately 8 degrees to 23 degrees. These variances are not adjustable in flight. (See fig. 11-9.)

Station 1 has no night photographic capability. To prevent voltage surges which could jeopardize the electrical system and blow circuit protectors, the switching sequence for station 1 is always as follows, when starting the camera: Master power, station control, station operate. When stopping the camera, the sequence that must be followed is station operate, station control, master power.

Station 2 is for KA-66A, 70mm panoramic (pan) camera, and has vertical capability only. The KA-66A is a low altitude panoramic reconnaissance camera, designed to provide horizon-to-horizon photographs from high speed, lowflying aircraft. The switching sequence for station 2 is the same as station 1.

Station 3 and 4 are side by side in the aircraft. (Refer to fig. 11-8.) Station 3 has one vertical and one port oblique window. Station 4 has one vertical and one starboard oblique window. These camera stations will accept cameras installed in both rotating and fixed mounts. (See fig. 11-10 and 11-11.)

The KA-40, KA-50 and KA-60 series cameras can be used in rotating mounts in both stations three and four. These rotating mounts can be controlled from the cockpit during flight to depression angles of 5, 15, 30, 81, 86, and 90 degrees.

The KA-68A, a low-altitude, panoramic camera, is mounted in a fixed vertical position mount in station 4.

MISSION CONFIGURATION

Four mission configurations are discussed in the following paragraphs, including general reconnaissance, uncontrolled mapping and charting, beach and amphibious reconnaissance, and night reconnaissance.

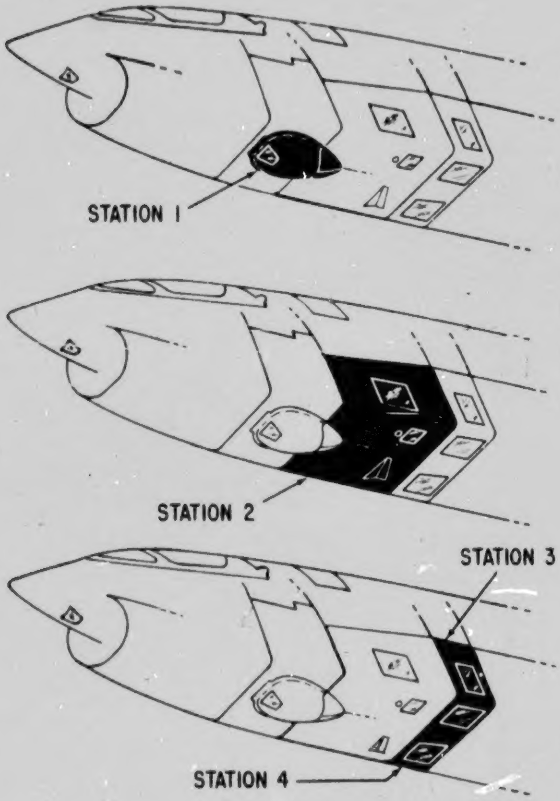


Figure 11-8.–RF-8G camera stations.

General Reconnaissance

The configuration for this type mission normally consists of a KA-45A or KA-51A camera in station 1, and one KA-66A mounted in station 2. One KA-45A with a 6-inch lens cone is mounted in the station 3 rotatable mount. For area reconnaissance, a KA-68A pan camera is mounted in station 4; for pinpoint reconnaissance, a KA-53A camera having a 12-inch lens cone is used in station 4.

Uncontrolled Mapping and Charting

The mapping and charting configuration is the same as the general reconnaissance configuration with the exception that pan cameras are installed in both stations 3 and 4.

Beach and Amphibious Reconnaissance

This configuration is also the same as the reconnaissance configuration with the following exceptions: one KA-45A, having a 6-inch lens and mounted in a rotatable mount, is placed in both stations 3 and 4.

Night Reconnaissance

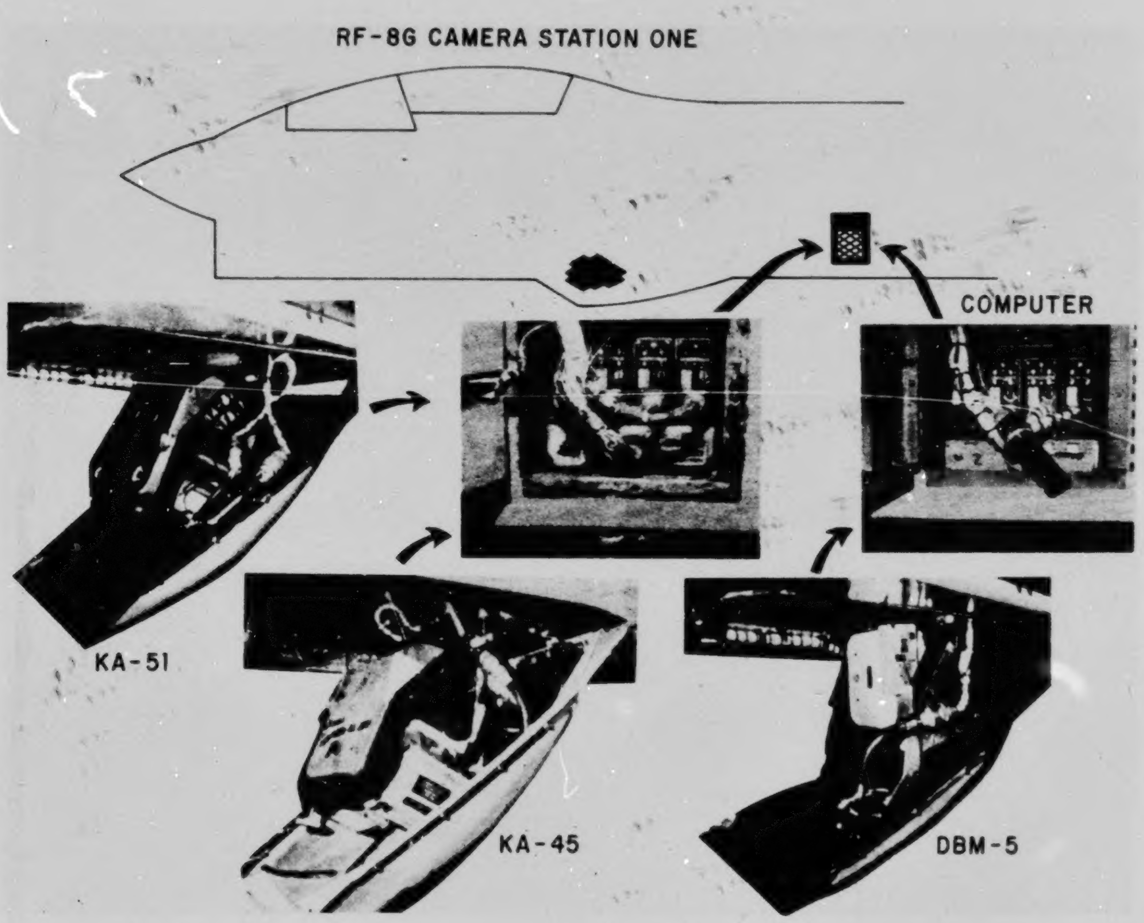
The night reconnaissance mission configuration consists of one KA-45A or KA-53A camera each in stations 3 and 4, a flash detector, and a flare release system. Each camera is mounted in a vertical or split vertical position. The camera operate system controls the ejection of flares, and the flash detector controls camera operation. A KA-51A may be used in stations 3 and 4 only in a split vertical position, and can be operated either simultaneously or sequentially.

A description of the various types of reconnaissance missions applicable to all types of reconnaissance aircraft is furnished in table 11-1.

RA-5C RECONNAISSANCE MISSIONS

Reconnaissance Attack Squadrons (RVAH) employ the RA-5C (Vigilante) aircraft to fulfill their assigned mission. That mission is to provide tactical commanders with up-to-the-minute tactical information acquired by the multisensor systems of the aircraft.

Photographer's Mates assigned to RVAH squadrons become members of a TEAM whose task it is to install, service, and maintain all photographic reconnaissance equipment. Some Photographer's Mates are assigned to the host activity (ship or station) to supplement the photographic processing personnel in IOIC. Others are temporarily assigned to IMA (Camera Repair) to augment the work force in that activity. The TAD personnel help to process the increased workload brought about by the presence of tenant units. This includes additional film to IOIC and cameras for repair to IMA.



PH.521

Figure 11-9.—RF-8G camera station 1.

FLIGHT CREW

The flight crew of an RA-5C is composed of two men, a pilot, and a radar air navigator. The pilot has overall responsibility for the aircraft and its assigned mission. He is also charged with the safe and proper operation of the aircraft in accordance with standard procedures. When necessary, the pilot will operate certain reconnaissance equipment.

The radar air navigator's responsibilities include the proper planning of assigned missions, navigation of the aircraft to and from targets, and the selection, operation, and monitoring of reconnaissance equipment.

The crew, although skilled and highly trained in their jobs, are dependent upon one another to accomplish their mission in a military and professional manner. A successful mission takes more than just a good flight crew, it takes trained and dedicated Photographer's Mates on the ground. The men who install and service the cameras in the reconnaissance system (photo line crew) are responsible for the checking of all camera systems to insure that they are in good working order before every mission, and that all

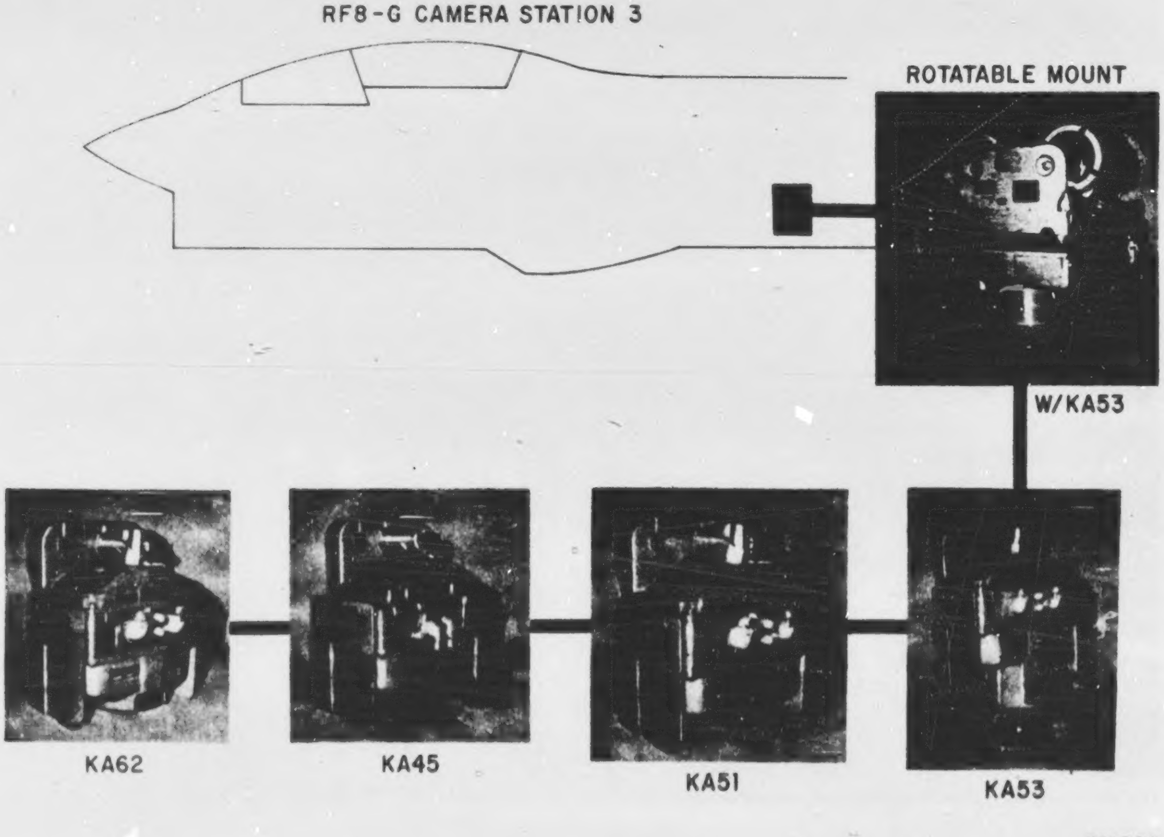


Figure 11-10.–RF-8G camera station three.

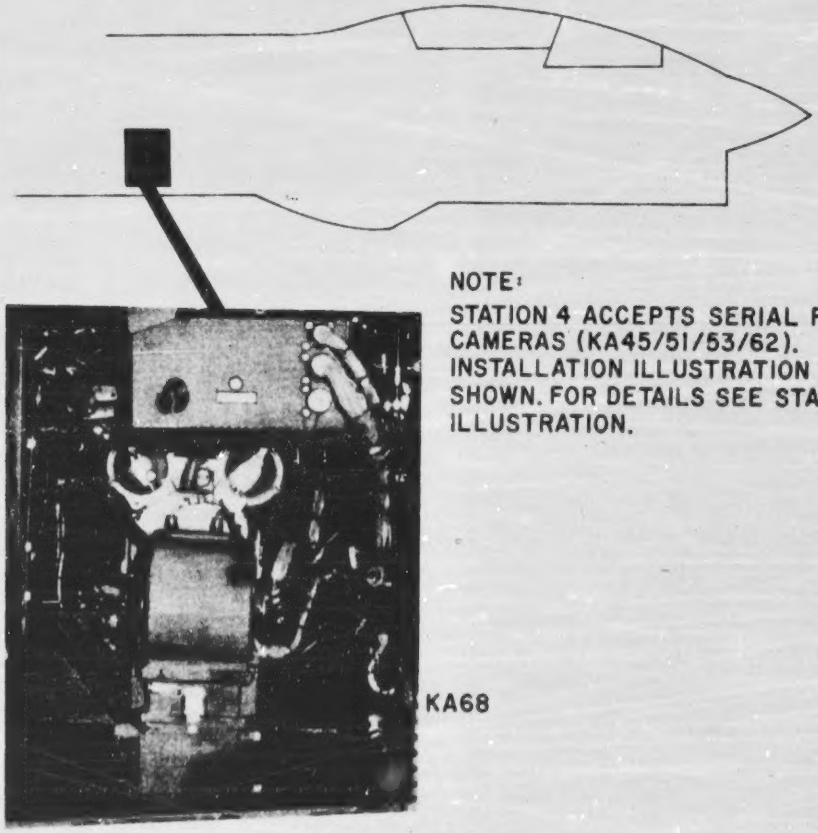
mission requirements as to type film, amount of film, proper filters, and proper camera settings are adhered to.

For the most efficient and productive operation of an RA-5C squadron's reconnaissance capability, there must be teamwork between all work centers. The overlapping areas of responsibility in the RA-5C systems require extensive liaison between work center supervisors to insure a GO system. A study of the reconnaissance systems packages will give an idea of why so much liaison and cooperation between shops are needed.

RECONNAISSANCE SYSTEMS PACKAGES (RA-5C)

The RA-5C has the capability of performing reconnaissance missions as follows:

1. Basic reconnaissance.
2. Low-altitude or beach reconnaissance.
3. High- and low-altitude general reconnaissance.
4. Low-altitude night reconnaissance.
5. Long-range reconnaissance.
6. Attack reconnaissance.



NOTE:
STATION 4 ACCEPTS SERIAL FRAME CAMERAS (KA45/51/53/62). INSTALLATION ILLUSTRATION NOT SHOWN. FOR DETAILS SEE STATION 3 ILLUSTRATION.

PH.523

Figure 11-11.—RF-8G camera station four.

Each of these missions requires a certain combination of reconnaissance packages. For example, the flasher pod package is required only for the low-altitude night reconnaissance mission. The specific cameras to be used in each package will depend upon the situation. The reconnaissance packages required for each type mission are shown in figure 11-12 through 11-17. These illustrations of reconnaissance packages are basic and can be modified to fill a particular requirement for any given mission.

Sensor Station Equipment

The term SENSOR STATION is used as a means of identifying the location of various systems and components. All cameras in the reconnaissance packages are housed in sensor stations that make up the reconnaissance system fairing which is attached to the underside of the aircraft.

Each sensor station and its associated equipment are illustrated in figures 11-18 and 11-19 and described in the following paragraphs.

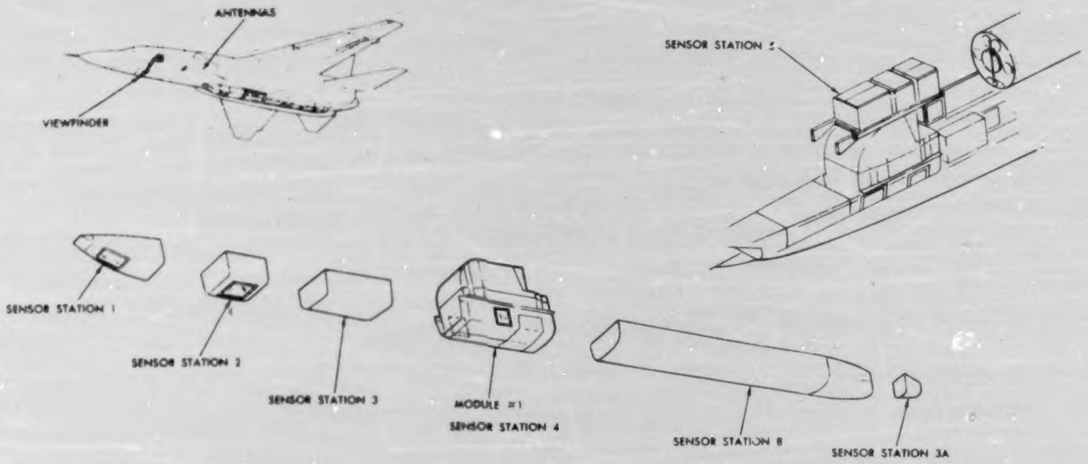
SENSOR STATION 1.—Access to sensor station 1 is accomplished by swinging the station down and forward. Inside the station, mounted on a fixed camera mount (at an angle of 11.5 degrees or 13 degrees depending upon the mount used), is a 6-inch focal length camera, the

Table 11-1.—Mission type descriptions.

Mission	Purpose	General Type of Target	Remarks
Area	Provide indications of enemy activity and basis for search of more selected area; provide data for updating of maps; provide data for updating orders of battle.	All reconnaissance targets.	One-time or initial coverage of an objective area. Usually small scale.
Route (Strip)	Provide information about a line of communication, ridge line, or shore line.	Road, railroad, helicopter approach, beaches, canals, navigable rivers.	Normally, the primary area of interest must be kept in the center one third of forward oblique and vertical strip photography, and along the lower one third line of side oblique photography. Area of primary interest should be kept in the center of infrared. Radar shadow, operating mode and altitude should be considered when planning for the side looking airborne radar.
Pinpoint (Point)	Provide detail about a target with respect to hardness, capability, defenses, bomb damage assessment, or technical analysis of equipment.	Building, airfield, bridge, gun emplacement, transportation intersections, etc.	Few photographs in large scale usually with stereographic coverage. Multisensor cover desirable.
Beach Reconnaissance	Provide detailed beach intelligence and shore line water depths information for potential amphibious operations.	Shore, terrain, and obstacles.	Vertical and oblique coverage to depth of 10,000 meters in land. Repetitive mission to detect change.
Helicopter Landing Area	Provide aids for pilot briefings to show approaches, landing areas, retirement lines, and terrain orientation features.	Terrain.	Repetitive cover with latest at D minus 1. Vertical strip and forward oblique.

Table 11-1.—Mission type descriptions. (cont'd.)

Mission	Purpose	General Type of Target	Remarks
Shipping Surveillance	Provide information on pattern significance and movement of shipping and cargo analysis.	Vessels.	A nine-view photographic sequence is desired of all ships designated special interest. For unidentified or non U.S. ships, a closeup of electronic equipment, vertical or plain view, and stereo pairs are desired.

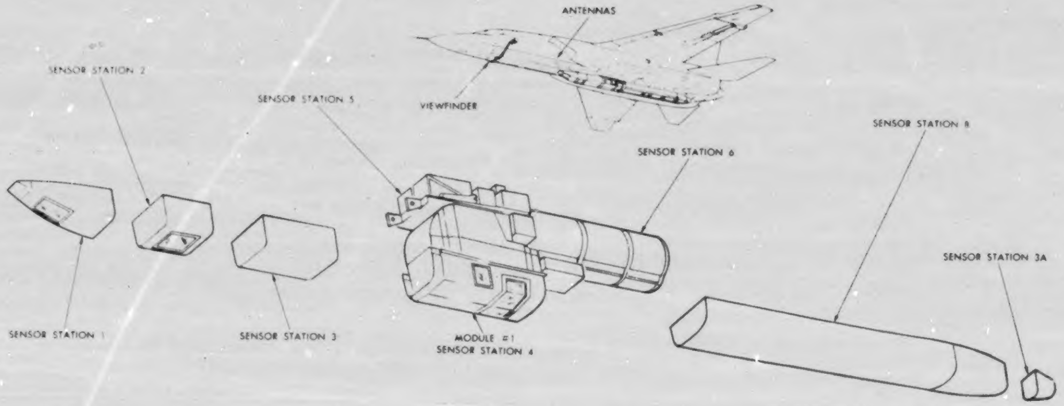


PH.524

Figure 11-12.—Basic reconnaissance.

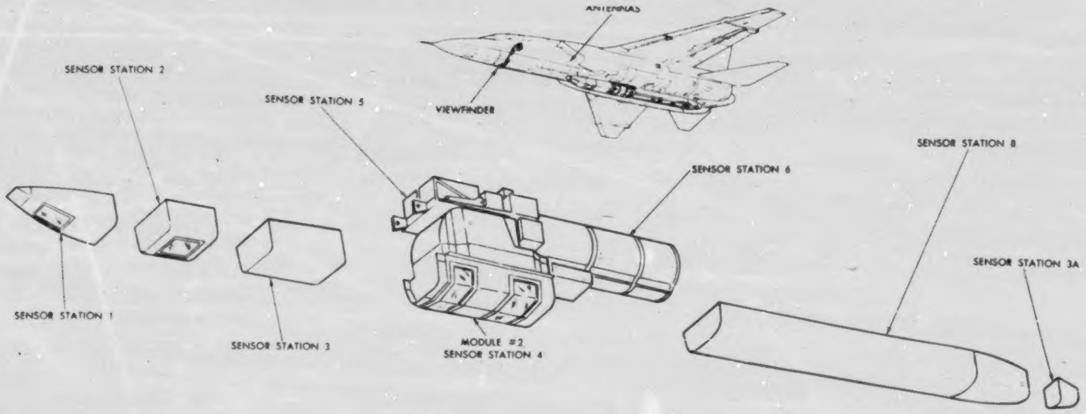
KA-51A. This camera uses the 100-foot cassettes and, in aircraft having the proper airframe change, the 250-foot cassettes. A light sensor associated with the camera is located in the fairing so that the field of view is through the window. Other equipment located in sensor station 1 includes a vacuum line, cooling air ducts, and defrost air nozzles.

SENSOR STATION 2.—Situated immediately aft of sensor station 1, this station is a continuation of the reconnaissance fairing. To gain access to the station, it is lowered down and to starboard. However, sensor station 1 must be lowered before this fairing can swing down. Contained in station 2 is a light sensor that operates in conjunction with the camera to give proper exposure settings and a camera mount which automatically corrects for drift of the aircraft. In aircraft with Airframe Change (AFC) No. 180 and Avionics Change (AVC) No. 436 incorporated (fig. 11-20), the 6-inch focal length KA-51A camera can be installed for night photography or day missions. When installed in this station, the KA-51A must use the 100-foot film cassettes. The KA-62A camera with a 3-inch focal length lens and 100-foot cassettes can also be installed in station 2, provided that the


ANTENNAS
SENSOR STATION 2
SENSOR STATION 5
VIEWFINDER
SENSOR STATION 8
SENSOR STATION 6
SENSOR STATION 3A
SENSOR STATION 1
SENSOR STATION 3
MODULE #1
SENSOR STATION 4

PH.525

Figure 11-13.–Low-altitude or beach reconnaissance.


ANTENNAS
SENSOR STATION 2
SENSOR STATION 5
VIEWFINDER
SENSOR STATION 8
SENSOR STATION 6
SENSOR STATION 3A
SENSOR STATION 1
SENSOR STATION 3
MODULE #2
SENSOR STATION 4

PH.526

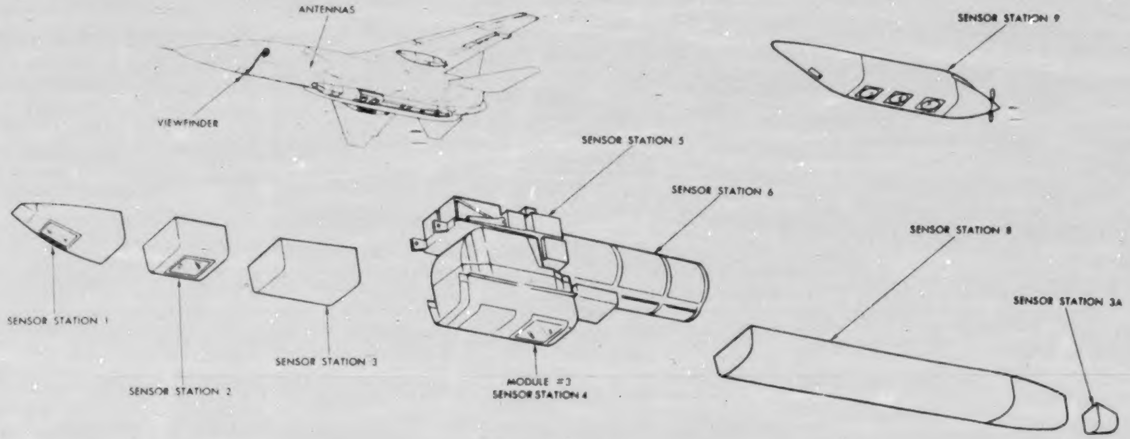
Figure 11-14.–High- and low-altitude general reconnaissance.

necessary AFC is incorporated. When the KA-51A or KA-62A cameras are installed, correction for drift is not possible.

SENSOR STATION 3.–This station is part of the PECM system, not a part of the photographic reconnaissance system.

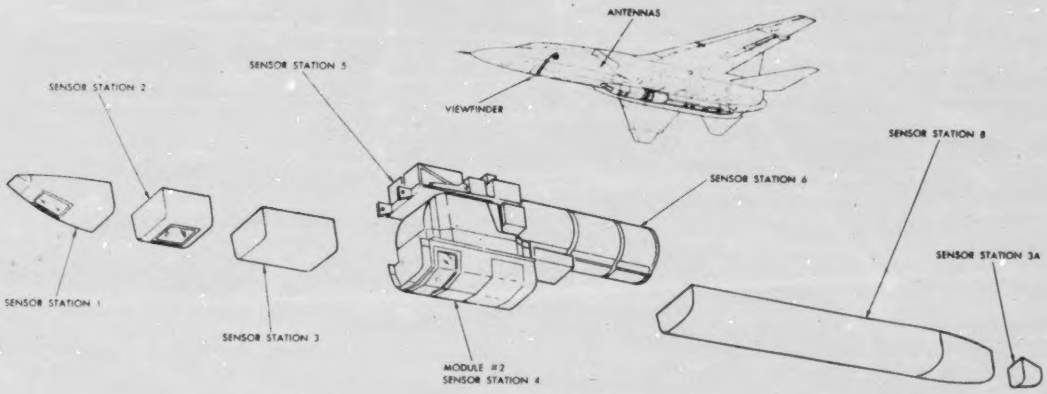
SENSOR STATION 4.–This is the most versatile of all the sensor stations. A choice of any one of four different modules, housing a variety of cameras and reconnaissance equipment, may be used. The choice depends upon the mission requirements. If a mission does not require the use of the cameras of this sensor station, then a special fairing can be installed to maintain the profile of the aircraft. This fairing (module) differs from the other modules because it has no camera installation capabilities.

To better understand the modular type construction of this reconnaissance package, and how it is installed into or removed from the


ANTENNAS
SENSOR STATION 9
VIEWFINDER
SENSOR STATION 5
SENSOR STATION 6
SENSOR STATION 8
SENSOR STATION 3A
SENSOR STATION 1
SENSOR STATION 3
SENSOR STATION 2
MODULE #3
SENSOR STATION 4

PH.527

Figure 11-15.—Low-altitude night reconnaissance.


ANTENNAS
SENSOR STATION 5
SENSOR STATION 2
VIEWFINDER
SENSOR STATION 8
SENSOR STATION 6
SENSOR STATION 3A
SENSOR STATION 1
SENSOR STATION 3
MODULE #2
SENSOR STATION 4

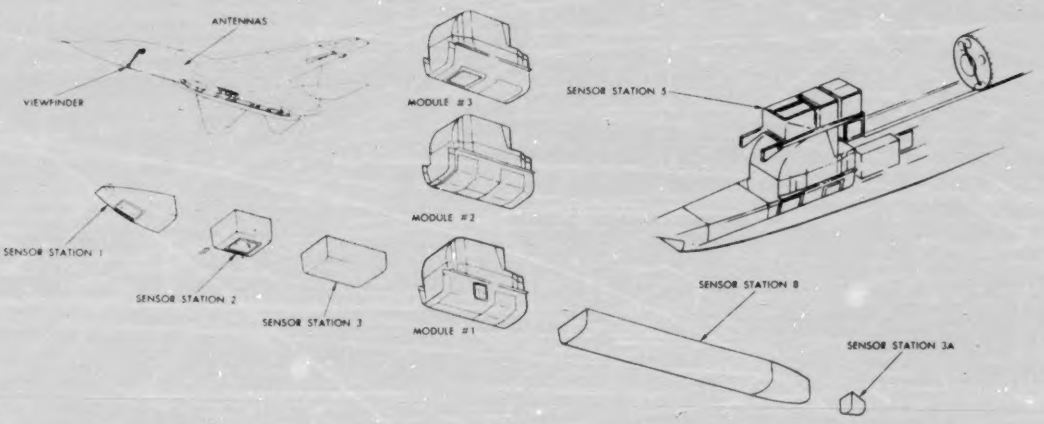
PH.528

Figure 11-16.—Long-range reconnaissance.

aircraft, a brief description is given here. For complete details, reference may be made to NavAir 01-60ABC-2-10, RA-5C Aircraft Reconnaissance Systems.

With the exception of the attack fairing, all modules are installed in the same manner. A module hoisting cable arrangement, permanently installed above the sensor station 4 area, provides a single-point hoist attachment for removing and installing camera modules. Figure 11-21 is a diagram of the hoist cable arrangement and shows the attaching points.

To transport the camera module to, and position it under, the aircraft, a module transport dolly is used. When this dolly is properly positioned, with the guide tubes in place, a standard hand-operated bomb hoist is attached to the end of the module hoist cable. The



PH.529

Figure 11-17.—Attack reconnaissance.

module is then cranked up into the sensor station 4 bay, as shown in figure 11-22.

NOTE: Sensor station 8 MUST be in the UP position when installing or removing the camera module in sensor station 4. Utmost caution should be used to prevent injury to personnel and equipment during this operation.

The camera modules available for use in sensor station 4 are numbered numerically, No. 1, No. 2, No. 3 and No. 3A. They are referred to as a 4-1 module, a 4-2 module, a 4-3 module and a 4-3A module. The basic configuration of each module is as follows:

1. The 4-1 module has two KA-51A, 6-inch focal length still picture cameras set at either 5 or 19.75 degrees. (See fig. 11-18.) For low-altitude or beach reconnaissance a 3-inch focal length, KA-57A panoramic camera is added to the module configuration.

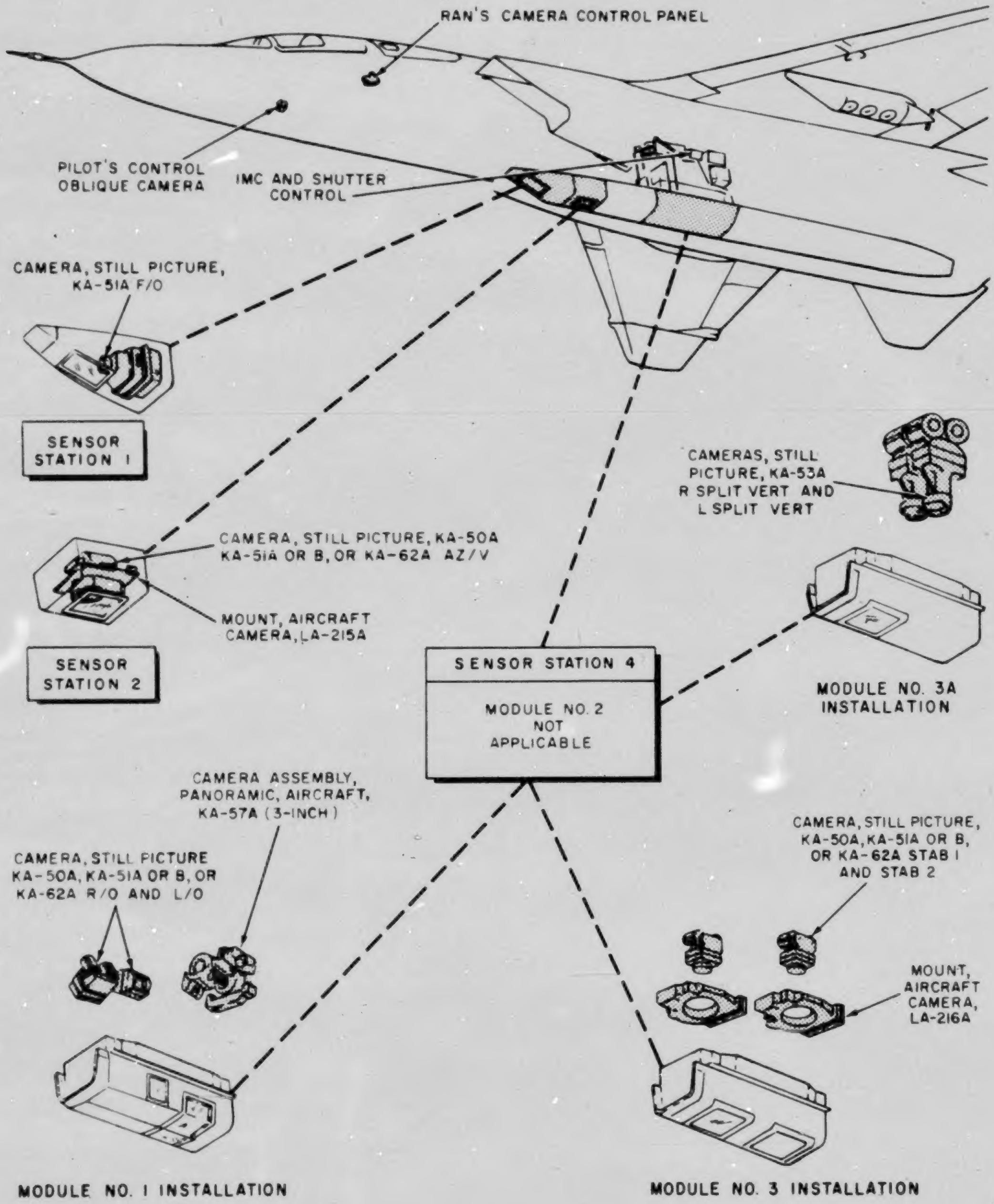
2. The 4-2 module has one KA-57A (3-inch) and one KA-58A (18-inch) panoramic camera when used for high- and low-altitude general reconnaissance. Only the KA-58A (18-inch) is installed for long-range reconnaissance. (See fig. 11-19.)

3. The 4-3 module is equipped with two vertically stabilized, 6-inch focal length, KA-51A still picture cameras. When used for night aerial reconnaissance, two wing-mounted, electronic flasher pods are part of the configuration. (See figs. 11-18 and 11-20.)

4. The 4-3A module contains two KA-53A (12-inch) day/night reconnaissance cameras. These cameras are mounted in the camera station at a depression angle of 81 degrees, in a right split vertical and a left split vertical position.

In addition to the cameras installed in each of the modules listed above, there are also various pieces of equipment for mounting the cameras, exposure control, and environmental control. Such equipment includes camera mounts (oblique and vertical), light sensors, temperature sensors, defrost air and cooling air systems, as well as portions of the electronic camera control systems.

SENSOR STATION 5.—This sensor station is a shelf located in the linear bomb bay, above the sensor station 4 area. For access to the equipment mounted on the shelf, it can be lowered (swing shelf). The fixed shelf of sensor station 5 is located forward of the swing shelf, as shown in figure 11-23. In aircraft having Airframe Change No. 177 incorporated, the swing shelf can be lowered and raised by a geared, drum and cable type hoist system. For the aircraft not having Airframe Change No. 177 installed, the Photographic line crew must manually release the shelf pins and physically lower the shelf to the down position. Care should be exercised in the process of manually


RAN'S CAMERA CONTROL PANEL
PILOT'S CONTROL OBLIQUE CAMERA
IMC AND SHUTTER CONTROL
CAMERA, STILL PICTURE, KA-51A F/O
SENSOR STATION 1
CAMERAS, STILL PICTURE, KA-53A R SPLIT VERT AND L SPLIT VERT
CAMERA, STILL PICTURE, KA-50A KA-51A OR B, OR KA-62A AZ/V
MOUNT, AIRCRAFT CAMERA, LA-215A
SENSOR STATION 2
SENSOR STATION 4
MODULE NO. 2 NOT APPLICABLE
MODULE NO. 3A INSTALLATION
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KA-57A (3-INCH)
CAMERA, STILL PICTURE KA-50A, KA-51A OR B, OR KA-62A R/O AND L/O
CAMERA, STILL PICTURE, KA-50A, KA-51A OR B, OR KA-62A STAB 1 AND STAB 2
MOUNT, AIRCRAFT CAMERA, LA-216A
MODULE NO. 1 INSTALLATION
MODULE NO. 3 INSTALLATION

PH.530

Figure 11-18.—RA-5C airborne subsystems—serial frame camera system components location.

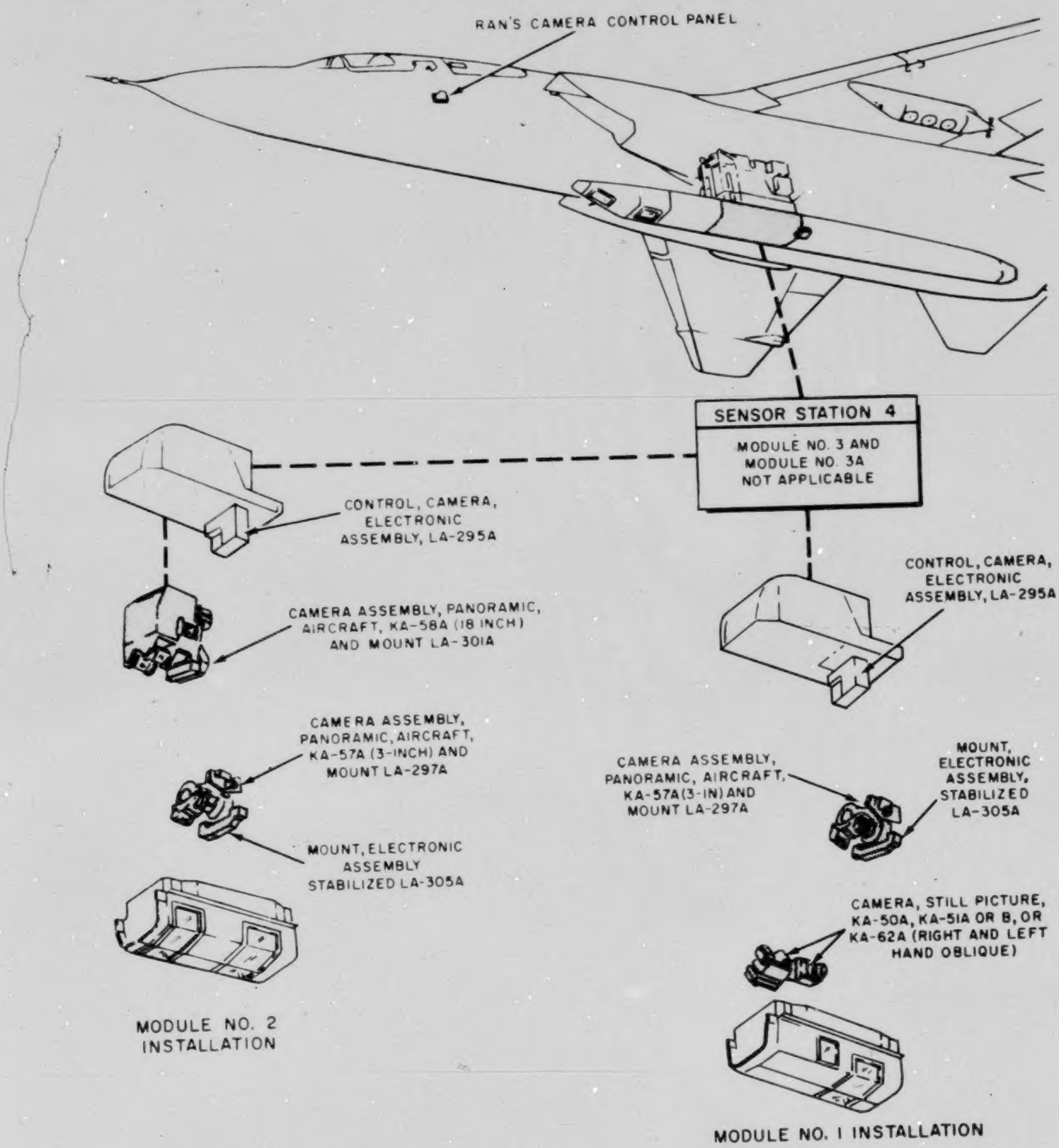
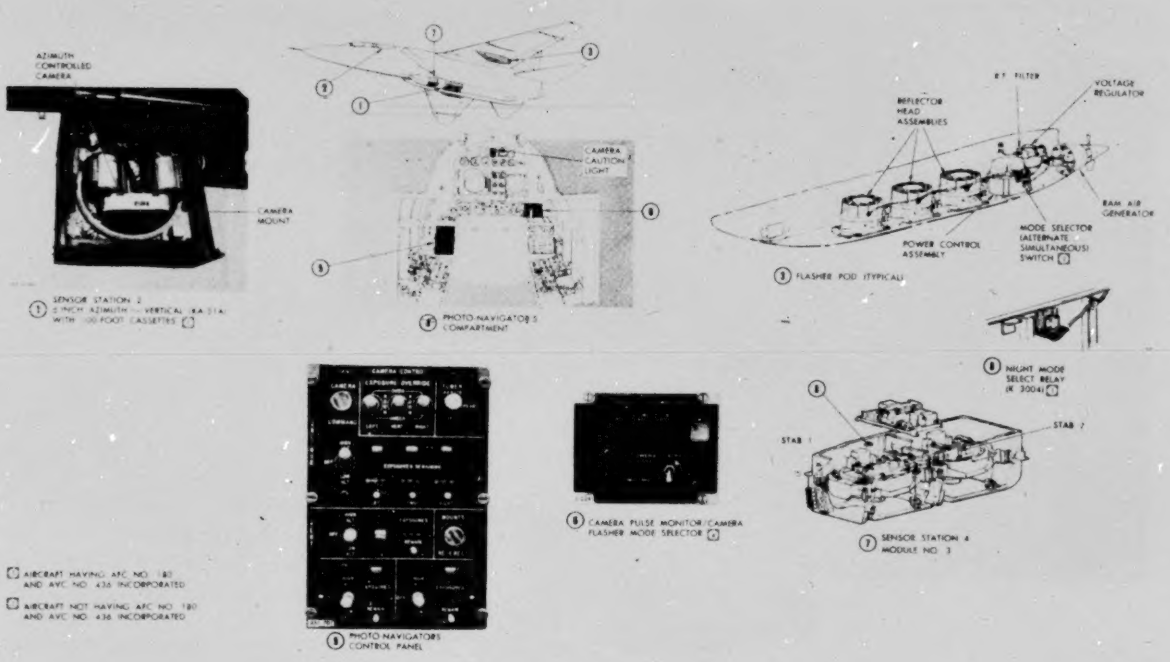

RAN'S CAMERA CONTROL PANEL
SENSOR STATION 4
MODULE NO. 3 AND MODULE NO. 3A NOT APPLICABLE
CONTROL, CAMERA, ELECTRONIC ASSEMBLY, LA-295A
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KA-58A (18 INCH) AND MOUNT LA-301A
CONTROL, CAMERA, ELECTRONIC ASSEMBLY, LA-295A
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KA-57A (3-INCH) AND MOUNT LA-297A
MOUNT, ELECTRONIC ASSEMBLY STABILIZED LA-305A
CAMERA ASSEMBLY, PANORAMIC, AIRCRAFT, KA-57A(3-IN) AND MOUNT LA-297A
MOUNT, ELECTRONIC ASSEMBLY, STABILIZED LA-305A
CAMERA, STILL PICTURE, KA-50A, KA-51A OR B, OR KA-62A (RIGHT AND LEFT HAND OBLIQUE)
MODULE NO. 2 INSTALLATION
MODULE NO. 1 INSTALLATION
PH.531

Figure 11-19.—RA-5C airborne subsystems—pan camera system components location.


AZIMUTH CONTROLLED CAMERA
CAMERA MOUNT
① SENSOR STATION 2
[illegible] INCH AZIMUTH — VERTICAL (KA-51A)
WITH 100-FOOT CASSETTES
①
②
③
⑦
CAMERA CAUTION LIGHT
⑤
⑥
② PHOTO-NAVIGATOR'S COMPARTMENT
R.F. FILTER
VOLTAGE REGULATOR
REFLECTOR HEAD ASSEMBLIES
RAM AIR GENERATOR
MODE SELECTOR (ALTERNATE SIMULTANEOUS) SWITCH
POWER CONTROL ASSEMBLY
③ FLASHER POD (TYPICAL)
④ NIGHT MODE SELECT RELAY (K 3004)
④
STAB 1
STAB 2
⑦ SENSOR STATION 4 MODULE NO. 3
⑥ CAMERA PULSE MONITOR/CAMERA FLASHER MODE SELECTOR
⑤ PHOTO-NAVIGATORS CONTROL PANEL
CAMERA CONTROL
EXPOSURE OVERRIDE
AIRCRAFT HAVING AFC NO. 180 AND AVC NO. 436 INCORPORATED
AIRCRAFT NOT HAVING AFC NO. 180 AND AVC NO. 436 INCORPORATED

PH.532

Figure 11-20.—Electronic flasher system installation.

raising or lowering sensor station 5 to assure the safety of personnel involved and the equipment

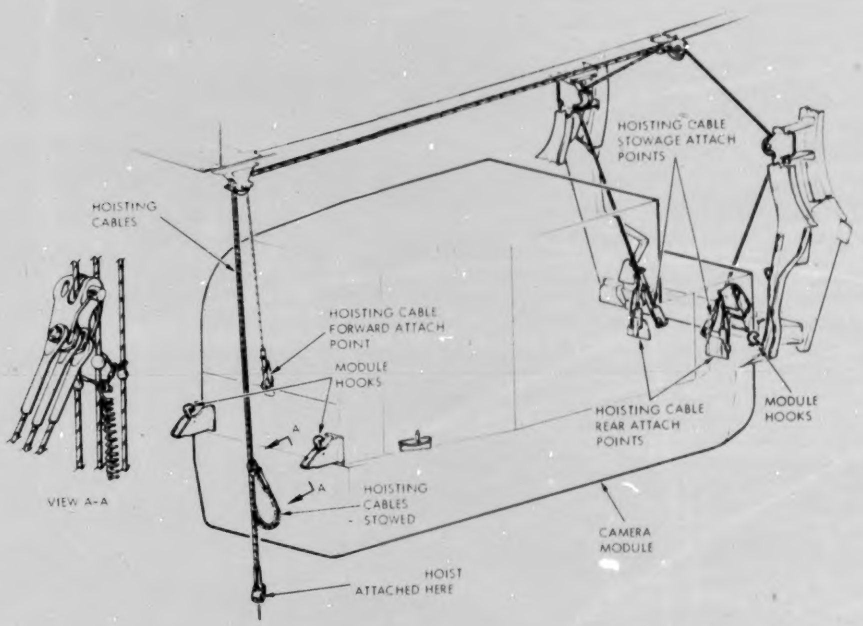
The items located on the sensor station 5 shelf that pertain to the photographic reconnaissance packages are the IMC and Shutter Control Assembly and the Signal Data Converter.

SENSOR STATION 6.—This station is not part of the aerial photographic reconnaissance system. It is located at the forward end of the linear bomb bay and houses Passive Electronic Countermeasures (PECM) mounting cans. (See fig. 12-10.)

SENSOR STATION 7.—This station is an area aft of sensor station 4 but is not a part of the photographic reconnaissance system.

SENSOR STATION 8.—This houses, primarily, side-looking radar (SLR) equipment that includes two antennas, hydraulic equipment for positioning and stabilizing the antennas, an SLR recorder (includes the camera and film magazine), a power supply and synchronizer unit, and a receiver-transmitter unit. Other items of equipment located in this sensor station include the data translator, three-head amplifier, and a passive electronic countermeasures system tape recorder. In aircraft having Airframe Change No. 244 incorporated, the configuration of sensor station 8 is modified to include an infrared (IR) detection set (IR mapping system).

SENSOR STATION 9.—Sensor station 9 actually includes two areas, one located on each wing at station 110. (See fig. 11-20.) The electronic flasher pods are attached at these two wing stations for night aerial photographic missions. They are used in conjunction with the


HOISTING CABLE STOWAGE ATTACH POINTS
HOISTING CABLES
HOISTING CABLE FORWARD ATTACH POINT
MODULE HOOKS
A
A
HOISTING CABLE REAR ATTACH POINTS
MODULE HOOKS
VIEW A-A
HOISTING CABLES STOWED
CAMERA MODULE
HOIST ATTACHED HERE

PH.533

Figure 11-21.—Sensor Station 4 module hoist.

cameras installed in sensor station 4, and (in aircraft having Airframe Change No. 180 and Avionics Change No. 436) in sensor station 2. The master flasher pod mounted on the port wing must be in place before the starboard pod will operate.

RECONNAISSANCE EQUIPMENT CONTROLS (PILOT)

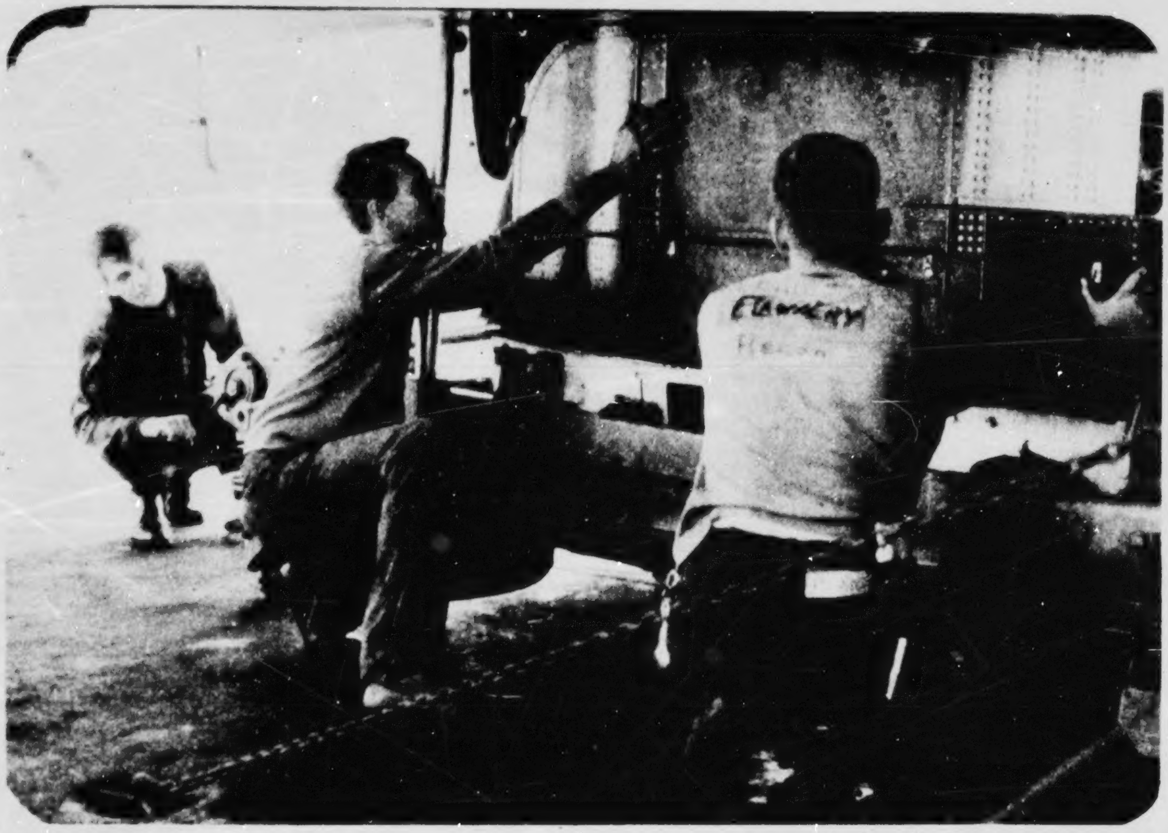
The pilot has control of only the oblique still picture cameras. For an illustration of the controls and their arrangement in the pilot's compartment, refer to figure 11-24.

To be able to operate the oblique cameras, the pilot must first take command of them. He accomplishes this by depressing the CAMERA COMMAND switch on his camera control panel (2, fig. 11-24). When the camera command switch is pressed, it switches control of all oblique cameras from the navigator's compartment to the pilot's compartment. The pilot can then operate the cameras as he chooses, either simultaneously or independently by setting the toggle switches on the control panel. After selection of the cameras that he chooses to operate, the pilot may then select the mode of operation by positioning the ON-OFF-STICK switch. For intermittent operation, the switch is placed in the STICK position; and for continuous operation, the switch is moved to ON.

Other controls located in the pilot's compartment are the GENERATOR CONTROL PANEL which contains the SYSTEM switch (3, fig. 11-24), INTERIOR LIGHT CONTROL PANEL (5, fig. 11-24), SIGHT MARKERS (7, fig. 11-24), TRIGGER SWITCH (1, fig. 11-24), and for aircraft with AFC 180 and AVC 436 incorporated, a CAMERA PULSE MONITOR INDICATOR (4, fig. 11-24) and a CAMERA PULSE MONITOR PANEL (6, fig. 11-24). Typical SIGHT MARKERS for the side oblique cameras are shown also as item 7 of figure 11-24.

RECONNAISSANCE EQUIPMENT CONTROLS (RADAR AIR NAVIGATOR)

The reconnaissance equipment controls located in the navigator's compartment are shown



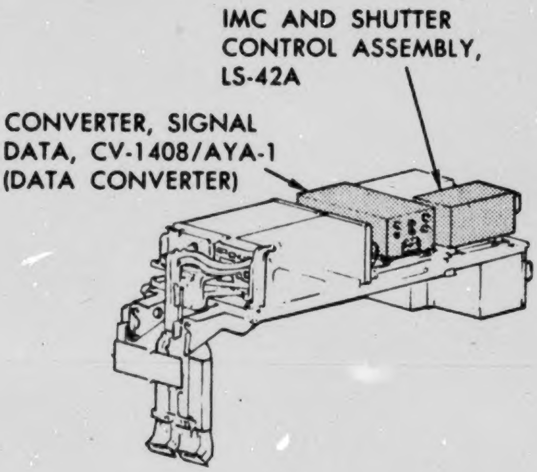
PH.534

Figure 11-22.—Sensor station 4 camera module installation.

in figure 11-25, and will be discussed in the following paragraphs.

Reconnaissance equipment controls located in the navigator's compartment includes the side-looking radar monitor scope (1, fig. 11-25) which, along with the side-looking radar control panel is the means by which the navigator operates the SLR. A camera control panel (2, fig. 11-25), located on the left-hand console, furnishes a means by which the navigator can energize, take command, and operate all photographic cameras. The Passive Electronic Countermeasures (PECM) Set, AN/ALQ-61, control panel, although not a part of the photographic system, is part of the reconnaissance equipment and is therefore included here. (See 4, fig. 11-25.) It is located on the left-hand console, aft of the SLR control panel. Located in the right-hand console is the navigator's indicating lights test switch (5, fig. 11-25). The camera pulse monitor panel, mounted in the forward right-hand console, contains four indicator lights that flash with each respective frame counter pulse. Also contained on this panel is a camera flasher mode selector switch which makes it possible for the navigator to select the mode of operation (alternate or simultaneous) of the flashers while in flight. (See 6, fig. 11-25.)

An optical viewfinder, mounted in the right-hand side of the instrument panel, provides the navigator with a clear view of the terrain along the line of flight. With the viewfinder, the


IMC AND SHUTTER CONTROL ASSEMBLY, LS-42A
CONVERTER, SIGNAL DATA, CV-1408/AYA-1 (DATA CONVERTER)

PH.535

Figure 11-23.–Sensor station 5 Shelf.

navigator is able to monitor certain camera control signals such as V_g/H and drift. Errors noted can be corrected with controls on the viewfinder control panel immediately below the viewing screen. In aircraft having AFC No. 582 incorporated, the control panel has a modified V/H control. (See 7, fig. 11-25.)

At the top of the navigator's instrument panel is a bank of reconnaissance systems CAUTION LIGHTS. These lights illuminate whenever there is a system malfunction, thereby warning the navigator of the system failure. (See 8, fig. 11-25.)

P-3C RECONNAISSANCE MISSIONS

The P-3C aircraft photographic system is composed of two separate and independently operated camera installations. The KA-74 camera used for surveillance is gimbal mounted in the forward radome of the aircraft. The KB-18 used for damage assessment photography is mounted in a vertical position in the aft section of the aircraft.

The photographic system of the P-3C aircraft is illustrated in figure 11-26.

The KA-74 and KB-18 were designed as day/night cameras; however, only the day capability is used in P-3C aircraft.

KA-74 CAMERA

The forward camera (KA-74) is manually operated by either the pilot or copilot by means of remote camera operate switches located on their respective pedestals. Camera operate switches for the KA-74 are also located on the A276 forward camera control box located at the copilot's station.

The camera can be displaced from the vertical position to a maximum of 30 degrees right, 30 degrees left or 30 degrees forward of center.

The KA-74 is a still picture camera producing a 4.5 by 4.5 inch format picture and can be operated in single or autocycle operation.

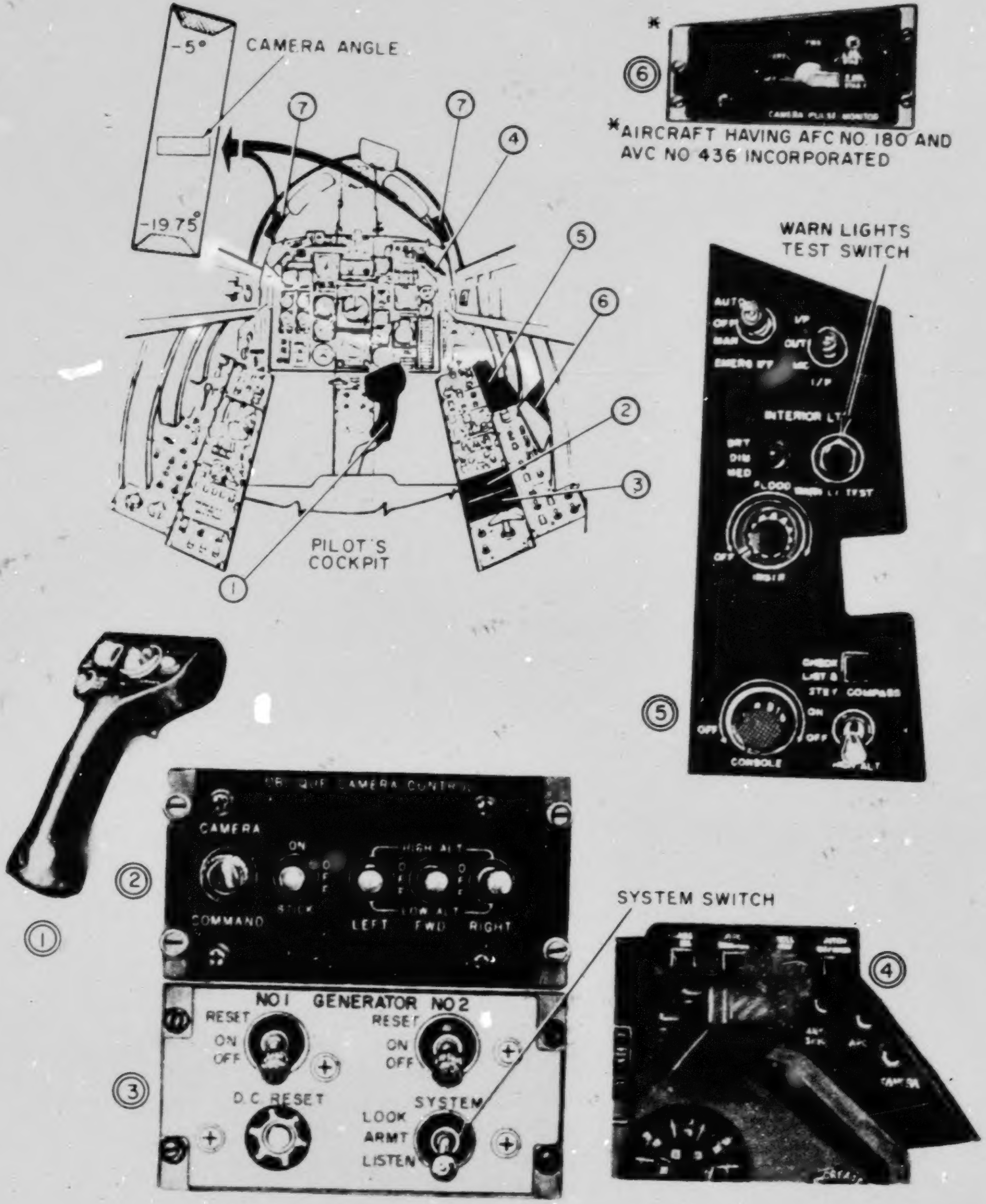
When the forward radome is opened, a radome power safety switch disconnects the A276 positioning switches. This radome safety switch also provides an automatic "stow right" function for the camera when the A276 power switch is placed in the off position. The A307 forward radome camera control provides the switches and controls the position of the camera mount when the radome is opened. The A276 forward camera control box controls the mount position when the radome is closed.

The KA-74 camera operates in either single or automatic mode. Automatic operation is obtained by placing the auto-single switch on the camera control box A276 in the auto position and depressing one of the three operate switches. (See fig. 8-48.) Four frames per second will be obtained for as long as the remote operate switch is depressed.

One frame per second operation (single mode) is obtained each time the remote operate switch is depressed by placing the auto-single switch in the single position and depressing one of the three remote switches.

KB-18 Camera

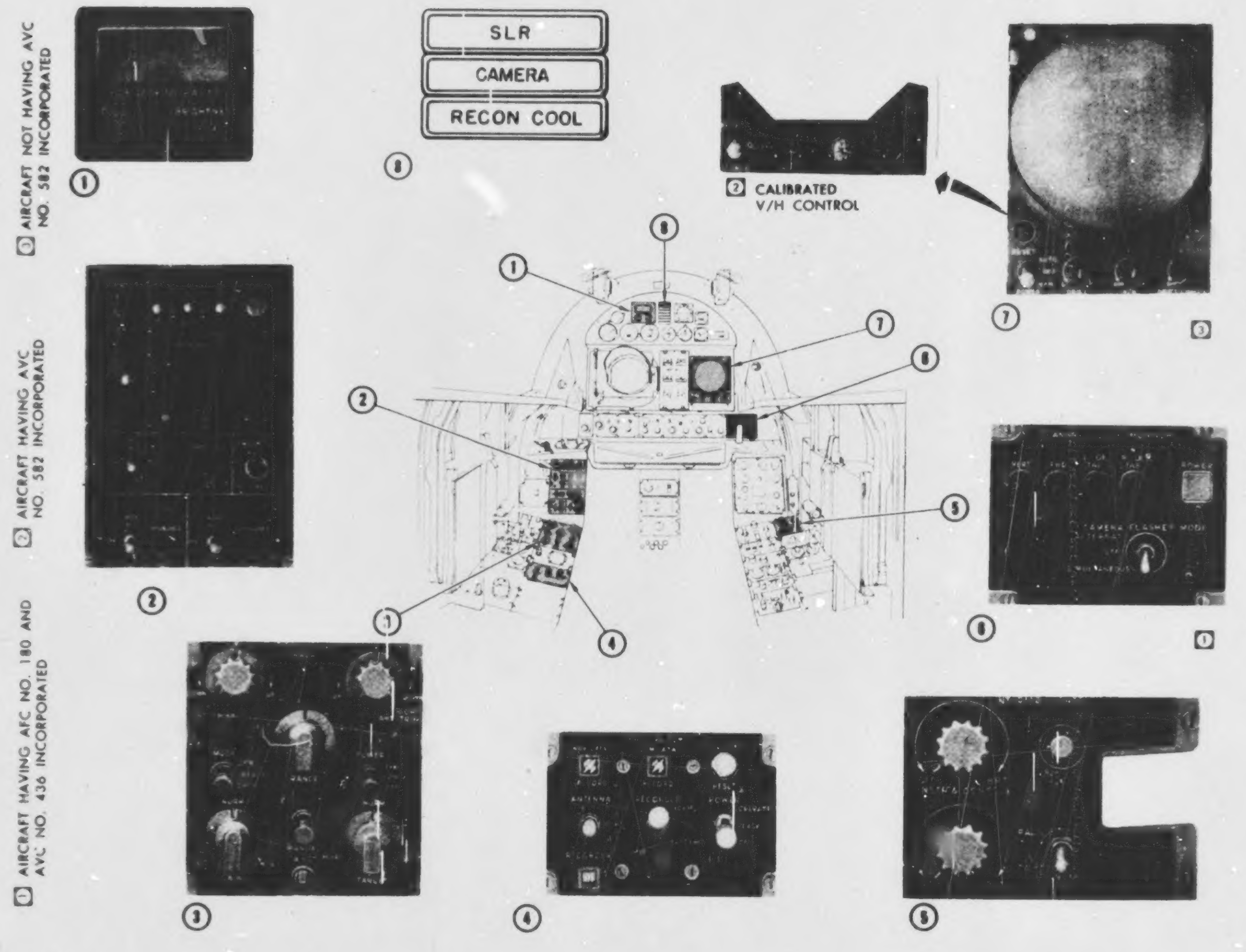
The aft camera (KB-18) is of the moving film type and will provide a fore-to-aft photographic coverage of 180 degrees along the line of flight and 40 degrees to each side. The KB-18 is


CAMERA ANGLE
-5°
-19.75°
PILOT'S COCKPIT
*AIRCRAFT HAVING AFC NO. 180 AND AVC NO 436 INCORPORATED
WARN LIGHTS TEST SWITCH
INTERIOR LT
FLOOD
CONSOLE
SYSTEM SWITCH
CAMERA
COMMAND
ON
STICK
HIGH ALT
LOW ALT
LEFT
FWD
RIGHT
NO 1 GENERATOR NO 2
RESET
ON
OFF
D.C. RESET
SYSTEM
LOOK
ARMT
LISTEN
1
2
3
4
5
6
7

PH.536

1. Trigger switch.
2. Camera control panel.
3. Generator control panel.
4. Camera pulse monitor INDICATOR.
5. Interior lights control panel.
6. Camera pulse monitor panel.
7. Camera angle SIGHT MARKERS

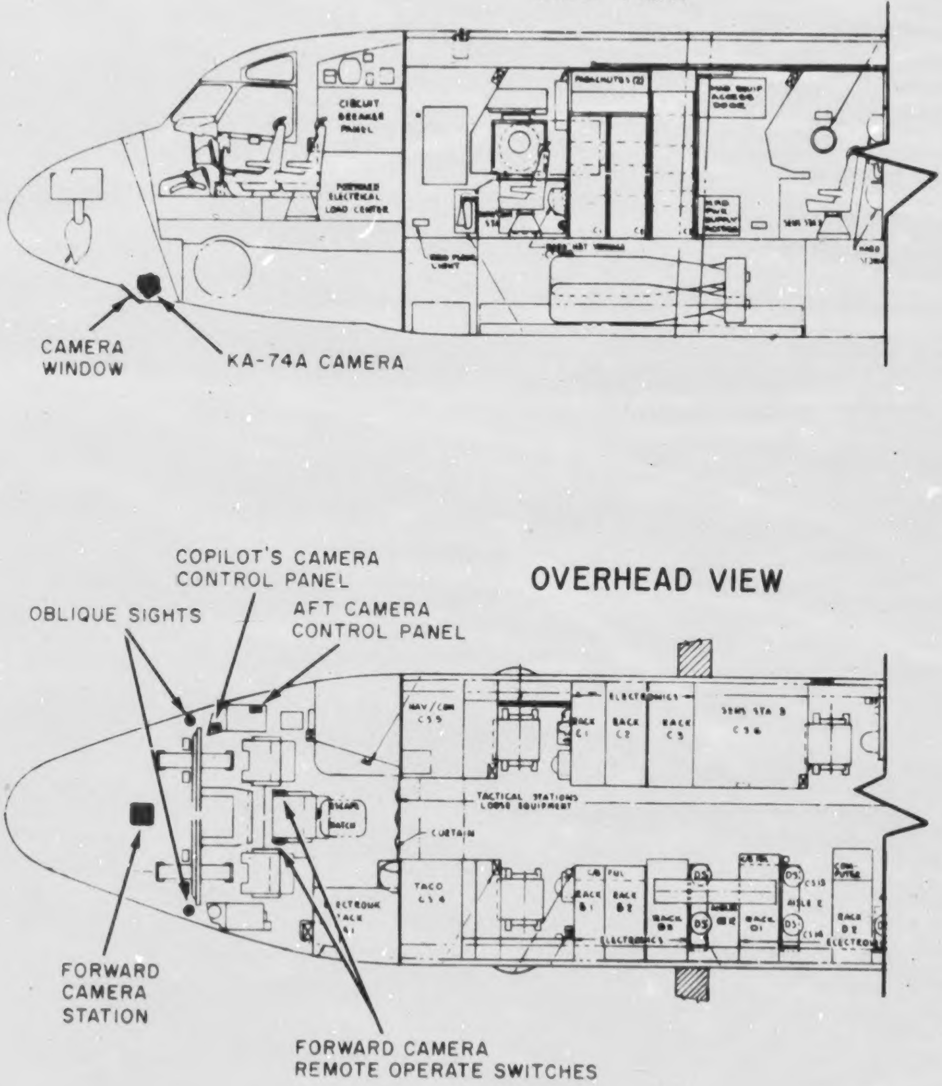
Figure 11-24.—Reconnaissance ystems controls and indicators—pilot's compartment.


① AIRCRAFT NOT HAVING AVC NO. 582 INCORPORATED
② AIRCRAFT HAVING AVC NO. 582 INCORPORATED
① AIRCRAFT HAVING AFC NO. 180 AND AVC NO. 436 INCORPORATED
SLR
CAMERA
RECON COOL
② CALIBRATED V/H CONTROL
①
②
③
④
⑤
⑥
⑦
⑧

PH.537

1. Side-looking radar monitor scope.
2. Camera control panel.
3. Side looking radar control panel.
4. PECM control panel.
5. Indicating lights TEST switch.
6. Camera pulse monitor/flasher mode selector.
7. Viewfinder screen and control panel.
8. Reconnaissance system CAUTION LIGHTS.

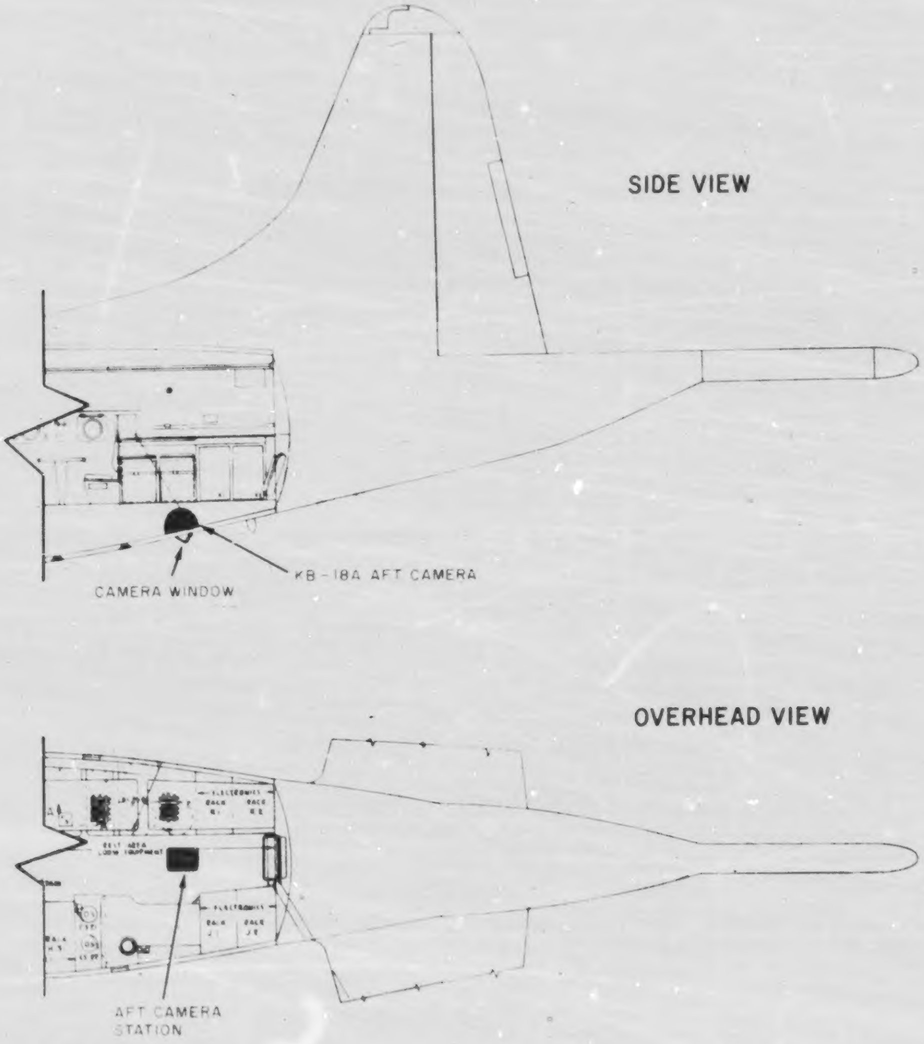
Figure 11-25.—Reconnaissance systems controls and indicators—RADAR AIR NAVIGATOR compartment.


SIDE VIEW
CIRCUIT BREAKER PANEL
FORWARD ELECTRICAL LOAD CENTER
CAMERA WINDOW
KA-74A CAMERA
OVERHEAD VIEW
COPILOT'S CAMERA CONTROL PANEL
OBLIQUE SIGHTS
AFT CAMERA CONTROL PANEL
NAV/COM CS 5
RACK C1
RACK C2
RACK C3
SENS STA 3 CS 6
TACTICAL STATIONS LOOSE EQUIPMENT
CURTAIN
TACO CS 4
ELECTRONIC RACK
RACK B1
RACK B2
ELECTRONICS
FORWARD CAMERA STATION
FORWARD CAMERA REMOTE OPERATE SWITCHES

PH.324

Figure 11-26.—(A) P-3C photographic subsystem components location diagram-nose section.

completely automatic when armed and actuated by external signals. The system can be activated by a switch on the aft camera control panel A311 mounted on the copilot's console or by an ord/operate signal from logic unit 2 stores release switches on the pilot's and copilot's control wheels or from the bomb-torpedo release switch on the PEU-74/A manual weapons control panel. When the system is activated, the camera will complete the cycle predetermined


SIDE VIEW
CAMERA WINDOW
KB-18A AFT CAMERA
OVERHEAD VIEW
ELECTRONICS
RACK
ELECTRONICS
RACK
AFT CAMERA STATION

PH.325

Figure 11-26.–(B) P-3C photographic subsystems components location diagram-aft section.

by the position of the controls on the LB-17A camera control.

Additional information on the KA-74 and KB-18 cameras, the A276 forward camera control box, A311 aft camera control panel, and LB-17A camera control can be found in chapter 8 of this rate training manual; in Photographic Systems Organizational Maintenance for the Navy Model P-3C Aircraft, NAVAIR 01-75PAC-2-11.1; and in chapter 21 of the PH 3 & 2 rate training manual, NavPers 10355-A.

ASW AND SHIP SURVEILLANCE PHOTOGRAPHIC TECHNIQUES

An increasing amount of ASW and ship surveillance photography is being conducted by aircraft types such as the P-3C having cameras that are automatically operated from the cockpit by the pilot or copilot.

Various types of aircraft still in use, such as the P-2 and P-3A, require the use of hand held cameras to accomplish ASW and/or ship surveillance photography. The photography in this situation is executed by the copilot or one of the aircraft crew members. This section will discuss the techniques and procedures for shooting ASW and ship surveillance photography with hand held cameras.

Aircraft Approach Patterns and Required Photographic Views

Ship surveillance and ASW photography require a minimum of five basic views. These required views of the target are as follows: Two three-quarter bow views, one from the port and the other from starboard; two three-quarter stern views, one from the port and the other from starboard; and one view of the target from as nearly vertical as possible.

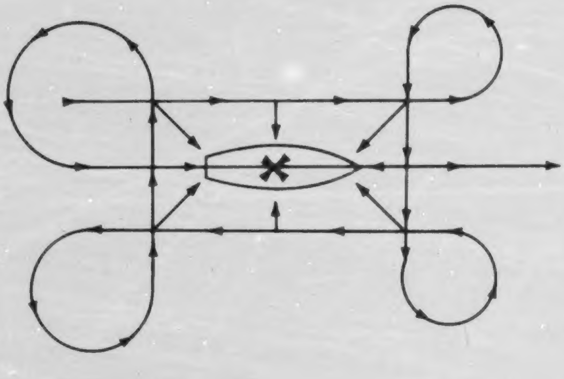
Targets that are of interest to intelligence require, in addition to the previously mentioned five-point coverage, four additional views. These four additional views include the following: A photograph from directly astern the target; a full port and a full starboard side view; and a photograph directly in front of the bow of the target. The aircraft approach pattern and required views for both five- and nine-point coverage are illustrated in figure 11-27.

The basic approach pattern shown in figure 11-27 enables the target to be photographed from all required points in the least amount of time. In addition this pattern gives the photographer two chances of obtaining the three-quarter bow and stern shots on the first pass over the target.

Fuller coverage of the target, especially if it is a large vessel, can be obtained by placing the image on a diagonal instead of in the usual straight fore and aft position. This allows a 3-inch image to be recorded on 2 1/4 by 2 1/4 format film, a 6-inch image on 4 by 5, and a 1 3/4 inch image on 35mm film.

Aircraft Photographic Limitations

A photographer stationed in the after station of certain aircraft types cannot see the target until it is about to pass under the wing of the aircraft. Situations such as this require the closest cooperation between the pilot and photographer. A few seconds before the target is to pass beneath the wing of the aircraft the pilot should give the photographer the standby warning "target coming up," the photographer, after receiving this warning, acknowledges by replying "standing by."



PH.538

Figure 11-27.—Aircraft approach pattern and required photographic points.

The ports in pressurized aircraft are constructed of a double layer of Plexiglas. Poor quality photographs result when taking photographs through the curved position of these type ports. The Plexiglas acts as an additional element in the optical system of the camera. A slight shift in the focus of the camera is produced by the Plexiglas because it has a different index of refraction than the camera lens elements. This shift in camera focus is greater at the larger f/stops. This problem cannot always be solved by stopping down because of poor existing light and/or the need for fast shutter speeds to arrest motion.

The best means of solving the problem of having to shoot through a Plexiglas opening is by adjusting the angle of the camera in relation to the photographic window. The photographer at the approach of the photographic run is usually shooting through the curved portion of the window at an angle approximately 25 degrees from the normal. Pictures of very poor definition are obtained at this angle. The camera is panned towards the rear flat portion of the window as the approach closes; this decreases the angle through which the photograph is taken. Shooting through the flat portion of the window when the angle is decreased improves the definition of the photographs.

Photographs of the best definition and quality can normally be acquired by the following procedure. The aircraft should be kept at an altitude and angle which will allow entire topside of the subject to be clearly shown in the photograph. Pick up the target in the viewfinder, keeping the center of the viewfinder centered on a specific point of the subject. As the aircraft approaches the target keep this specific point centered in the camera viewfinder, as you pan the camera towards the flat portion of the window. Keep the lens as close as possible to the window but avoid touching it with either the lens or camera. When the selected point on the subject (seen through the center of the viewfinder) reaches a point that is parallel to the window and at the flat portion of the glass, take the photograph. This procedure may allow only one or two photographs to be taken on a single pass but the quality and definition of the photographs will be improved.

The various techniques involved in the shooting of aerial photographs are covered in chapter 14 of this rate training manual and in chapter 21 of the PH 3 & 2 Rate Training Manual, NavPers 10355-A. Therefore, the remainder of this section will be limited to discussing ASW and ship surveillance photographic requirements and their identification.

ASW and Ship Surveillance Photographic Requirements

The basic five-point coverage and nine-point coverage for intelligence purposes were discussed earlier in this section. In the obtaining of this coverage the scale and angle of view are important factors. The image size should be as large as possible without cutting out any of the subject. The views showing the three-quarter bow shots and stern views should be taken at an angle which will show as much of the deck cargo as possible. The port and starboard beam shots should also be taken at a high enough angle to show deck cargo and assist in determining the length of the vessel. A vertical view of the target is also useful in determining its length and size and deck cargo.

Specific items to look for and photograph in ship surveillance photography are as follows:

1. Type of ship: tanker, freighter, passenger.
2. Electronic equipment: antennas, radar masts, etc.
3. Weapons.
4. Deck cargo: size and shape of crates, and type and amount of equipment being hauled.
5. Nationality of ship.

Color photography is useful in obtaining information that cannot be provided by black and white photography, such as colors and characteristics of crew uniforms, national origin of crew and passengers, fabrication of material used to cover deck cargo, and any other information that can be best interpreted by color.

Specific items to photograph in ASW photography are as follows:

1. Anything that can be used in classifying and identifying the vessel including size and shape of the conning tower, sail section, any odd looking equipment, and side numbers (frequently old side numbers will show under the new numbers).
2. Electronic gear.
3. Weapons.

Identification of ASW and Ship Surveillance Photographs

ASW and ship surveillance photographs must be fully identified if they are to serve their purpose of helping the Photo Intelligence personnel make an accurate intelligence report. Identification of ASW and ship surveillance photography should include the following information:

1. Nationality.
2. Name (side and funnel markings).
3. Geographic coordinates.
4. Date and time of day.
5. Focal lengths of lens used.
6. Altitude or distance from target.
7. Direction of target movement.
8. Speed of target.
9. Pilot and photographer's name.

10. Squadron designator.
11. Magnification of photograph (if enlarged).

Some cameras have a transparent plastic data plate that can be inserted into the focal plane for recording data on each frame of photography. For cameras not having this capability, the side number of the aircraft should be photographed at the beginning of the flight. This will assist the photographic lab in identifying the roll of film when several rolls have been sent for processing and printing.

AERIAL PHOTOGRAPHIC MISSIONS USING HELICOPTERS

As a senior Naval photographer it is very likely that at times you will be involved in taking of aerial photographs and/or planning an aerial photographic mission using a helicopter. In the planning of an aerial photographic mission a cardinal rule is to know and understand the objective of the mission. The following list of questions may be used in the planning of an aerial photographic mission:

1. How will the photographs be used? And in what form will the final product be used: black and white, or color prints; 8 x 10 or smaller prints, or murals; color slides, or large color transparencies?
2. When must the final product (prints or color slides) be available?
3. Where is the subject (the exact location)?
4. What is required to be shown about the subject?
5. How large an area does the subject cover? For example, is the subject a small building, a large one, several buildings in a group, or maybe even an overall of an entire military complex?
6. What are the terrain features in the subject area?
7. What navigational hazards are present in the subject area?
8. From what direction to the subject will you have the best view?
9. What time of day presents the best lighting angles and conditions to show the best view of the subject?
10. What type of camera, focal length lens, and type of film will be best suited for the mission? (Subject area and final product are two primary factors that must be considered.)
11. What is the best approximate altitude for the mission?
12. What is the predicted weather forecast for the time of the mission?
13. What type of helicopter will be available for the mission?
14. Arrange, if at all possible, a preflight briefing between the pilot who will be flying the mission and the assigned photographer.

SELECTING THE CAMERA

There is no one best hand held camera for aerial photography. The camera best suited for the photographic mission whether it is a 4 x 5 inch or larger format 35mm, 120mm, or one having a 70mm roll-film pack, is determined by the required end product of the assignment. This may range from 35mm color slides to black and white or color murals. The 35mm camera is well adapted for most aerial photographic missions because of its compactness; light weight; large film capacity; ease of handling; and wide variety of interchangeable lenses and available photographic emulsions. The KS-80A (Nikon F) and the KS-94A (Beseler Topcon Super D), two 35mm cameras adapted for handheld aerial photography, are covered in chapter 20 of the Rate Training Manual PH 3 and 2, NAVPERS 10355-A.

SELECTING THE FILM

The first factor to be considered when selecting the type of film to use, is whether or not the end product is to be black and white prints, color prints or color slides (transparencies). Once this has been determined, other important factors to consider in selecting the best film for the assignment are a combination of the following: Light intensity; motion; weather conditions; haze; altitude; and subject contrast or reflectance ratio of the subject, at the time of the mission. The film characteristics, as covered in chapter 17 and 20 of the PH 3 and 2 Rate Training Manual, NAVPERS 10355-A can serve as a guide in determining the best suited film to use for the prevailing conditions.

It will make the pilot and photographer's job both easier, and will save time and money in addition to obtaining a better end product, if a preflight briefing can be arranged between the two before the mission. When in the air it is very easy to become disoriented as things do not appear the same from above as they do on the ground. This problem can be minimized by studying available road maps, topographic maps, and/or charts of the area to be photographed, to determine landmarks that can readily be seen from the air. Based upon your study of the mission plan, determine the safe, legal altitude and the primary and secondary angles that will give the best results.

In helicopters voice communication is often very difficult between the photographer and the pilot because of noise. The best way to communicate is normally a set of hand signals arranged prior to the mission between the pilot and the photographer. The pilot will probably have a better understanding of the photographer's needs if a previous set of hand signals have been arranged than he would from the use of inappropriate terms and/or jargon he may fail to understand.

The photographer should remember that when in the air the pilot will not be looking through the viewfinder of the camera. Therefore their views of the subject will be considerably different. Because of this difference in viewpoint the photographer must be able to direct the pilot into positioning the aircraft in the best possible position to photograph the subject, and with a minimum amount of time and effort. It should be noted when directing the pilot that he may be unable to see the subject being photographed or have a good view of it when the photographer is placed in the best possible position for filming the subject.

After the photographer has planned the mission with the cooperation of the pilot, checked and double checked his cameras, film supply, and other accessories he is ready to fly the photographic mission, provided that factors such as weather, haze conditions, and light intensity are within the acceptable tolerance ranges.

Determining The Correct Exposure For Aerial Photographs

Before taking off on the mission the photographer should estimate the correct exposures for the aerials by using a light meter, to determine the correct exposure for ground level photography. If a filter is being used, be sure to allow for the filter factor.

After you are airborne and at the altitude from which you will be working take an exposure meter reading of the subject. At low altitudes and with no visible haze present the exposure as indicated by the exposure meter should be very close to the exposure determined on the ground. The camera should be set half-way between the exposure that was calculated on the ground and that calculated in the air. If haze is visible and you are filming the subject from a high altitude, the indicated exposure as determined by the meter will be much higher than the exposure determined on the ground. The exposure meter reading in the air is probably in error because the light being reflected by the haze is likely to be biasing the meter, and not giving you a true exposure reading of the subject. In this situation the camera should be set near the exposure that was calculated on the ground.

It is more economical and efficient to take a wide range of exposures (provided conditions permit) than to refly the mission. The calculated ground exposure should be increased in 1 f stop increments (1/2 stops if color reversal film is being used) until after the exposure reading that was determined at the working altitude has been reached.

The photographer should remember that although high haze levels, high altitude, and/or high oblique photography will normally cause subject contrast to be reduced and will increase apparent exposure latitude, these factors also tend to contribute to a tendency of aerial photographers to overexpose film under these conditions. In aerial photography the subject is generally at infinity so the photographer is not generally concerned with stopping the aperture of his lens down in order to obtain depth in field. He should, however, use the fastest shutter speed available on his camera that prevailing conditions allow.

Frequently the object being photographed will be much darker or lighter than its surrounding area. The reflectance of this background area will predominate in the exposure reading and the result in either under- or over-exposure of the target image on the film. It is recommended in situations of this type that the substitution method of determining exposure as discussed in chapter 7 of the PH 3 & 2 Rate Training Manual be used.

Lighting

The time of day that the photo mission is flown will determine the length of the shadow cast by the subjects, and also to some degree the amount of atmospheric haze that will be present. During the summer months the effects of atmospheric haze can usually be minimized if the photo mission is flown between the hours of 0900 and 1030 (although haze is generally worse in the morning hours) or from 1400 until 1 hour before sunset. The hours from 1030 until 1400 are not considered as the best times for taking aerial photographs. The results of taking aerial photographs during these hours, with the sun behind the camera, or on an overcast day, will be the same as taking a photograph on the ground using flat-fill in lighting. The photographs will lack modeling, a feeling of depth, and apparent contrast.

CROSS LIGHTING.–Aerial photographs taken when the light is at an angle to the subject of 90 degrees to about 135 degrees will usually have the best overall visual appearance. Cross lighting casts shadows which provides modeling, increases the apparent contrast of the subject being photographed, and gives a feeling of depth to the photograph. However, both cross lighting and back lighting will cause shadows to be cast. If these shadows are deep or heavy they may obscure details that were desired in the final product. For example, a large object could cast a deep (heavy) shadow over a smaller nearby object that might obscure necessary details in the smaller objects.

BACK LIGHTING.–The aerial photographer seldom uses back lighting intentionally for aerial photographs, because of its tendency to obscure shadow details, emphasize haze and reduce apparent contrast. However in certain situations the effects of back lighting may be used in creating a desired mood and may turn an otherwise drab photograph into one that is picturesque.

Motion

Aerial photographers are not only concerned with the speed of the aircraft but the jolting effects of up-drafts and down-drafts in turbulent air and aircraft vibrations which can be transmitted to the camera. Contrary to the notion of many novices, a hovering helicopter does not make an ideal platform for aerial photography. The helicopter loses the additional lift obtained when it has forward speed; this diminishes the control the pilot has over the aircraft, and the engines will tend to overheat. The severe vibrations that are set up will be transmitted to the photographer and camera, resulting in unsharp photographs. Fast shutter speeds or, if a motion picture camera is being used, fast frame rates, are required to compensate for the problems of motion. The effects of normal vibration (not a hovering helicopter) can be largely avoided by insuring that no part of your body from the waist up, or the camera, is in contact with the aircraft at the time of the exposure(s). Engine vibrations and forward image motion can be minimized, by the pilot reducing power to the aircraft as you approach the desired position, banking the aircraft slightly and letting it slide toward the photographic subject. Image motion either directly toward or directly away from the camera is less than image motion at a 90 degree angle to the camera. When the aircraft is side-slipped in the direction of the subject, image motion will be toward the camera. If necessary when filming at right angles to the subject, the camera can be panned with the subject to minimize motion.

AERIAL MOTION PICTURE PHOTOGRAPHY

The same techniques used for aerial still photography, with a few exceptions that will be covered in this section, can be applied to aerial motion picture photography. The length of a motion picture scene taken from an aircraft appears much shorter in time on the screen when it is being projected than when the scene was originally filmed. When scenes that are too short are taken they are very disturbing to the viewing audience. Image motion, contrary to the belief of many novices, is also a problem in aerial motion picture photography. Normally, ground motion photography is filmed at a framing rate of 18 or 24 per second. This framing rate is insufficent for aerial motion picture photography. Factors such as the speed and altitude of the aircraft, film exposure index, and lighting conditions play a part in determining what frame rate to use. Therefore no set formula or rule can be given. It is generally accepted, however, that the framing rate for aerials should be one and one-half to two times the normal frame rates of 18 frames per second (fps) for super 8mm cameras and 24 frames per second for 16mm cameras.

AERIAL MOTION PICTURE TECHNIQUES

The motion picture camera must be kept steady when filming a scene, and any necessary pans made slowly and smoothly. The photographer's upper body and the camera must avoid any contact with the aircraft during filming, to reduce the effects of engine vibration. Slipping the aircraft towards the subject does not work out very well for motion picture photography as it may provide an undesirable zooming effect.

The shortest focal length lens that is practical should be used for aerial motion picture photography. It is very difficult to maintain a steady image on the screen when using a long focal length lens. A camera having a lens turret containing different focal length lenses or a camera with a zoom lens can be used to alter the audiences view of the scene. However the photographer, must resist the temptation to misuse and/or overuse the zooming capability of motion picture cameras with this feature.

Changing the focal length of the lens (the aircraft remaining at the same relative altitude) can often add variety and interest to the scene. However, unless zooming at the same time the scene is being filmed is required, in order that a special effect be achieved, focal lengths should be changed only between scenes. In either aerial motion picture or still photography, avoid having any part(s) of the aircraft, such as wings, doors or wheel struts, in the photograph. When concentrating on your subject it is very easy to look past such obstructions without seeing them.

SAFETY

The aerial photographer when either filming or observing from an open door of an aircraft should use a gunner's belt or similar safety device, which is attached to the aircraft proper, to minimize the danger of falling out. The belt should be fastened tightly around his waist. The belt should have only enough slack in its length to allow for limited freedom of movement.

To reduce the chances of your equipment falling out of the aircraft, carefully check the security of the fasteners on the neck or wrist strap of the camera(s), light meter or other accessories and use these straps at all times. After a piece of equipment is no longer required, place it in a secure location, away from any outside openings of the aircraft. Items left in an open doorway are easily lost, if accidently kicked out or if the aircraft should suddenly make a sharp bank. Dropping or throwing anything out of an aircraft in flight is not only hazardous to persons and property below, but can bring a quick ending to an otherwise perfect photo mission.

CHAPTER 12

MOTION PICTURE EQUIPMENT

The purpose of this chapter is to discuss motion picture cameras, magnetic sound recorders, and lighting equipment used in the Navy so that the trainee will be able to operate and maintain this equipment. Among the topics and equipment discussed are Super 8mm photography, Arriflex 16mm cameras, KB-19A and B strike cameras, high speed motion picture photography, sound recording, and motion picture lighting.

SUPER 8mm MOTION PICTURE PHOTOGRAPHY

The U.S. Navy will continue to use 16mm cameras, related equipment and films for most original motion picture footage. There will, however, be occasions in which it will be advantageous to take the original motion picture footage on super 8mm when duplicate prints are not required.

The Navy presently plans to release training/educational and internal information films on super 8mm with magnetic sound tracks. Motion picture release footage on 16mm format, will continue to be released, however, for those user needs that cannot be met by super 8mm.

Super 8mm is more economical in film, equipment, and laboratory processing costs, and is less complicated and more portable than either 16mm or 35mm motion picture equipment. Furthermore, many advantageous features common to super 8mm such as power zoom lens, automatic exposure systems, lightweight electrical film drive systems, and lightweight, simply operated cassette tape recorder sound units are available (if at all) in only the more expensive 16mm and 35mm cameras.

Super 8mm motion picture equipment is small and lightweight and can be easily set up and operated by only one man. Sixteen millimeter and 35mm motion picture equipment normally require two, and preferably three, men to set up and operate the equipment.

A 50-foot cartridge of super 8mm film exposed at sound speed (24 frames a second) provides a 2 1/2 minute duration film. By contrast, a 50-foot roll of 16mm also exposed at the same frame rate will provide only 1 minute and 23 seconds; 35mm provides only 33 seconds of filming.

At the present time the quality of the super 8mm image is not as good as 16mm when they are both projected to the same size. The super 8mm image is not able to fill as large a screen as 16mm when both projectors have the same size focal length lens and are the same distance from the screen.

SUPER 8mm SOUND

One method of obtaining lipsynch super 8mm sound films is through the use of a cassette tape recorder. The camera operated at sound speed (24 frames a second) is equipped with a synch pulse generator that places a synchronizing signal on the cassette sound recording tape while the film is being exposed. After the film has been shot, both the recording tape and exposed film are sent to a photographic laboratory capable of handling sound films. In the laboratory the film is processed and a magnetic sound strip placed on it. The sound from the recording tape is then transferred to the magnetic sound strip on the film.

ARRIFLEX 16mm MOTION PICTURE CAMERAS

There are several models of Arriflex cameras, each having certain particular features. The

Arriflex models S/B and M/B, however, are prevalent in the Navy and will be covered in this section. The S/B and M/B models have common capabilities in most areas with both models being able to handle the same assignments. However when the assignment requires a motion picture camera with a large film capacity, the M/B model is desirable.

ARRIFLEX 16mm MODEL M/B

The M/B is designed for use with a 200-foot, 400-foot, or 1,200-foot external film magazine. The M/B, because it has no internal film capacity, is a very lightweight, compact unit. At present the M/B is the smallest and lightest weight 16mm motion picture camera capable of handling motion picture film up to 1,200 feet in length.

Film sprockets, instead of being built into the camera, are built into each M/B magazine. This facilitates magazine changes to such an extent that loading and unloading the magazines on or off the camera can be accomplished in seconds. Other features of the M/B differing from the S/B will be covered in the discussion regarding the S/B model Arriflex.

ARRIFLEX 16mm MODEL S/B

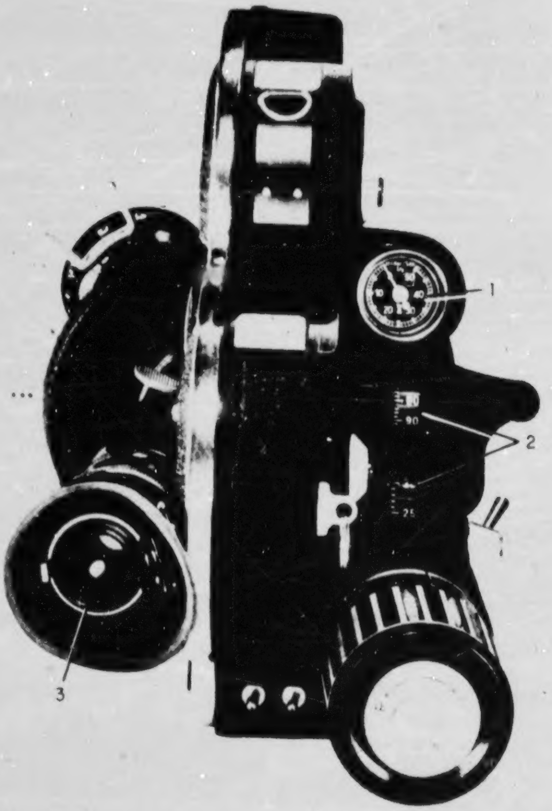
The S/B has a 100-foot internal film capacity and does not require the use of external film magazines like the M/B. However, 200- and 400-foot external magazines are available and can be used when needed. The external S/B magazines, however, are not the same quick change design as used by the M/B model, having neither the built-in film-feed or takeup sprockets of the M/B magazines. The Arriflex model 16 S/B is illustrated in figures 12-1, 12-2, and 12-3.

Arriflex 16 S/B Camera Controls

The camera speed, indicated as frames per second by a tachometer which with registers from 0 to 50 (fps), is controlled by a graduated rheostat ring. Below the tachometer are the film footage and frame counters. These counters are easily zeroed by their respective setting disks.

Located beneath the film footage and frame counters is the camera drive motor. At the back of the motor is a knurled disk marked "R"–"F". Film runs forward through the camera when the disk is turned all the way to "F", and in reverse when the disk is turned all the way to the "R" position. There is no limit to the amount of film that can be reversed, and any frame can be easily located by means of the frame and footage counters, which register in both directions. Both the camera motor and magazine torque motor must be set to run in the same direction, either both forward or both reverse.

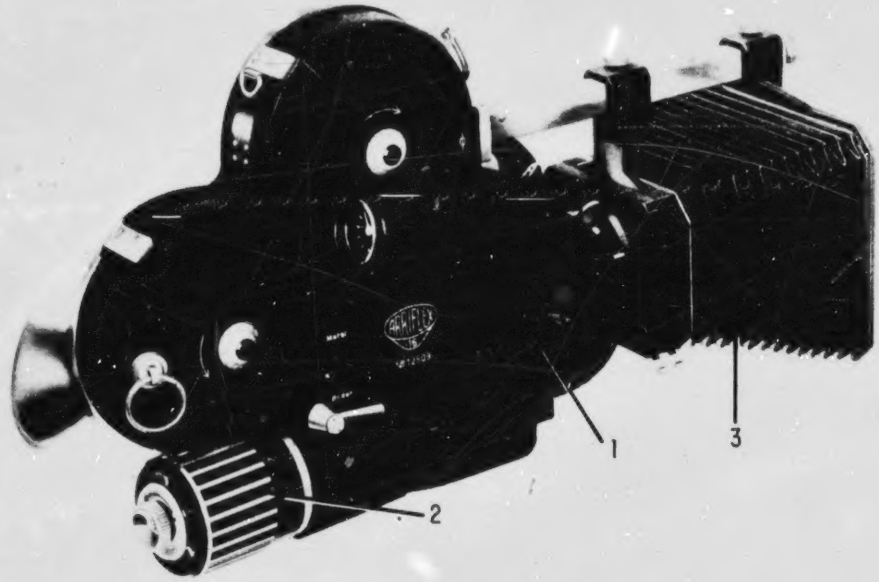
The film transport knob located in the center of the motor is used to turn the shutter lever by



PH.539

1. **Tachometer, calibrated 0-50 fps.**
2. **Footage and frame counters**
3. **10x Reflex viewfinder eyepiece.**

Figure 12-1.—Arriflex model 16 S/B rear view.



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1. **Contoured handgrip.**
2. **Camera drive motor.**
3. **Adjustable matte box and filter holder.**

Figure 12-2.—Arriflex model 16 S/B right side.

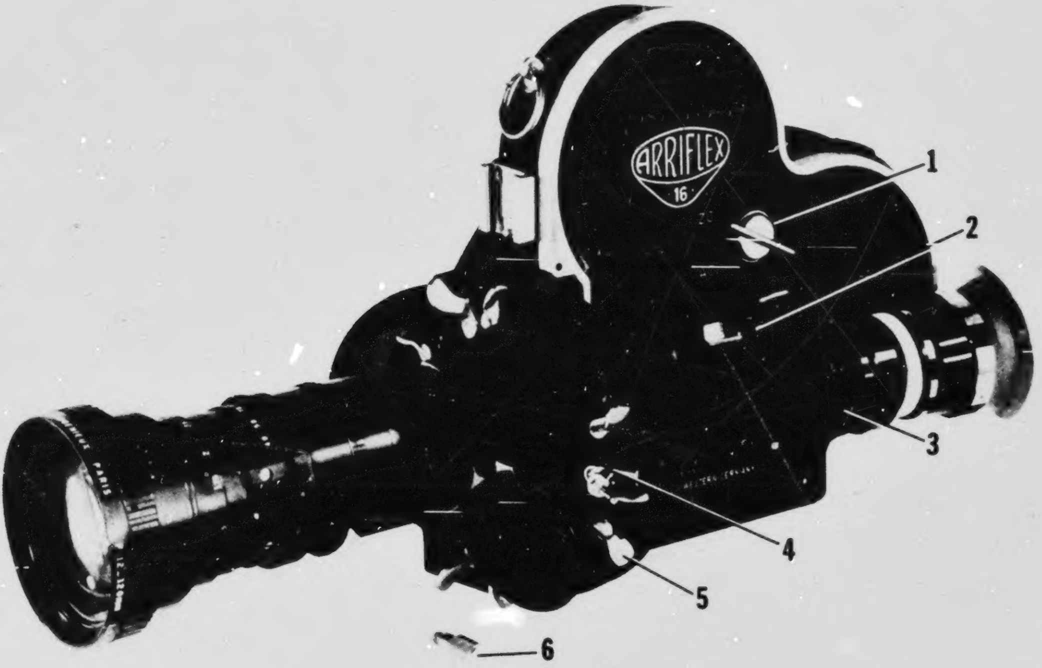
hand for sighting, and to actuate the registration pin and film transport claw during loading operations.

Opening and Loading

Turn the cover lock to "O" and lift off the cover. Place a 100-foot film spool firmly on the upper spindle. Then pull off about 2 feet of film. Open the film gate (fig. 12-4) by pressing down on the latch knob and swing the pressure pad assembly open on its hinges. Before threading the film, open the pressure roller assembly. Thread the film around the sprocket drum, swinging off the pressure roller if necessary. Then arrest the film by swinging back the pressure roller. Lead film to the film gate by forming a loop according to the marking inside the camera body. Insure that the registration pin is in the disengaged position.

Place the film into the gate so that a perforation hole is exactly in line with the registration pin. Hold the film down with two fingers of one hand at both ends of the gate and turn the transport knob until the registration pin locks the film into place. Then close the gate, thread the film around the sprocket drum, and close the pressure roller.

The sprocket spindles have single sprockets (to permit the use of sound perforated film). It is important that the film be seated properly by moving it back and forth with two fingers over each spindle until you can feel that a sprocket has engaged a perforation. The pressure roller assembly can be rocked on its pivot when the upper sprocket has been threaded to hold the film in place. When the lower sprocket has been



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1. **Camera door latch.**
2. **Main stop-start switch.**
3. **Reflex view finder.**
4. **Three-lens divergent turret.**
5. **Lens retaining latch.**
6. **Lens zoom lever.**

Figure 12-3.—Arriflex model 16 S/B left side.

threaded, the lower portion can in turn be rocked into place.

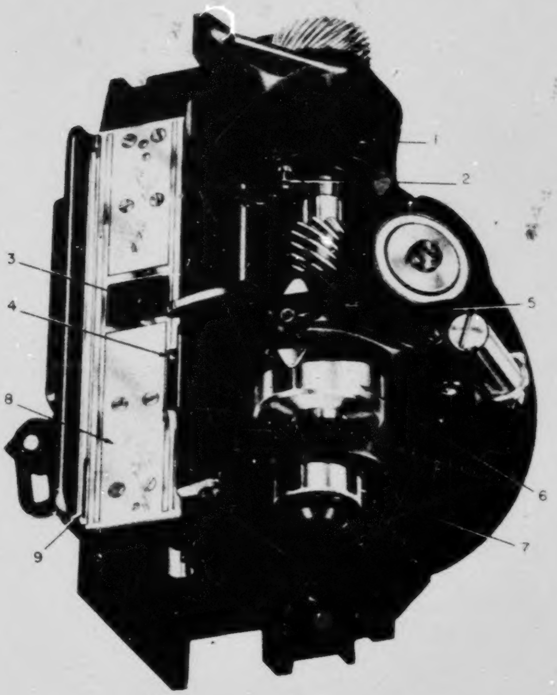
Manually turn the transport knob, located at the end of the motor housing, clockwise to move the film a few inches through the gate. Connect the camera to its power supply. Push down the internal switch and observe about 2 feet of film roll through the camera. (A 100-foot roll of daylight loading film actually contains about 111 feet of film to allow enough for the leader and trailer).

Close the camera cover and move the lock to "C", insuring that the outside switch is released and in the open position, otherwise the cover cannot be closed. Then set the footage counter and frame counter to "0" by their respective control disks.

Arriflex 16 S/B Magazine System

The external film magazine can accomodate a 100-foot or a 200-foot daylight loading spool. It can accomodate a 200-foot or a 400-foot darkroom load of core-wound film.

Each magazine requires its own size torque motor for film takeup. Torque (takeup) motors are rapidly interchanged from magazine to magazine, so only one takeup motor is required for each size magazine. The takeup motor is driven through internal wiring by the 8-volt d-c camera power supply. These torque motors can be operated either forward or reverse, the same as the camera. The 400-foot film magazine and its respective torque motor are illustrated in figure 12-5.



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1. Registration cam.
2. Registration cam lever, with sapphire cam follower.
3. Registration pin.
4. Hardened tool steel pulldown claw.
5. Cam follower for pulldown.
6. Double-action box cam for pulldown.
7. Main shaft—mounted in instrument quality ball bearings and temperature compensating supports.
8. Extra long film gate; all parts ground and hand polished.
9. Spring loaded side pressure rail.

Figure 12-4.—16mm Arriflex model S/B and M/B film gate and registration pin.

LOADING THE MAGAZINE WITH DARKROOM LOADS.—With a 200- or 400-foot darkroom load, open the magazine cover by turning the lock bar from "C" to "O." Open the cover and place the film on the left spindle with the loose end to the right and center the film roll between the flanges of the friction guide roller. Push the loose end through the left-hand magazine throat past the light trap rollers to the outside, around the nose and back through the right-hand throat into the magazine again. Next turn the takeup core so that its slit is directed like this (/) and not like this (\). Attach the film end into this slit and wind up enough film by hand until it is secure or attach the film to the core with a little transparent tape.

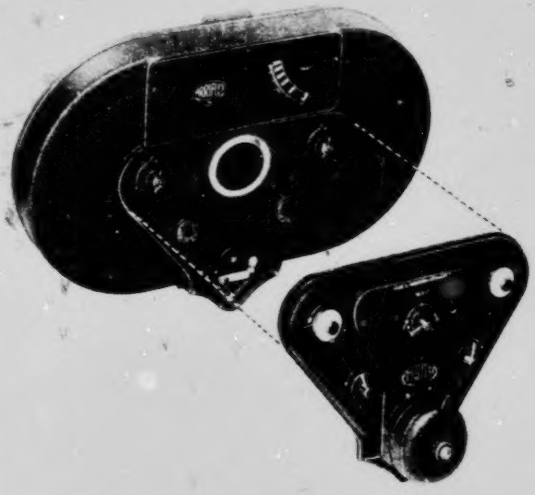

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Figure 12-5.—400-foot film magazine and torque motor for the Arriflex 16 S/B.

Close the cover of the 400-foot magazine by first putting its lower edge against the magazine body in a wide angle, making sure that the two lugs on the cover lineup and properly engage the mating slot in the magazine housing. When properly done the cover will readily close. Turn the lock to "C." (The cover of the 200-foot magazine is provided with hinges.)

The film footage indicator for the Arriflex 16 S/B is connected to the supply spool and shows the approximate amount of exposed film.

To load the 400-foot magazine with 200-foot daylight loading spools, remove the core adapters by pushing down on the centers of the spindles (they have the same locks as the camera spindles). Place the supply spool on the left side, loose film to the right, and thread as before; take up the film on the empty spool, and wind up several turns. When using a 200-foot spool the friction roller guides are not needed. Lock them both to their respective catches.

The film indicator to the outside of the magazine cannot be used. Instead the film counter on the camera is utilized. It should be remembered that the counter provides for 118 feet, therefore 200 feet of film is used up when the counter shows 82 on its second round.

Buckle Switch With Manual Override Mechanism

The Arriflex cameras incorporate a buckle switch to automatically stop the camera, in case the film jams or breaks; it also stops the camera automatically at the end of the film.

The buckle switch operates properly only when the lower film loop is formed exactly according to the marking on the camera body. When the end of the film has passed through the film gate, the lower loop shortens, thereby pulling up the switch roller which in turn cuts off the camera motor. The camera can be turned on again only after the pressure roller assembly has been opened and closed as prescribed in the loading instructions. This manipulation, which is always being performed when film is threaded into the camera, causes the buckle switch to reset itself. If the pressure roller assembly is not closed properly, the camera will not start. Any shortening of the lower loop (e.g., film jam in camera or end of film) actuates the buckle switch. Never actuate the switch roller by hand.

The buckle switch override mechanism permits cutting the buckle switch out of the electrical circuit of the camera at the option of the camera operator. Experience has shown that on certain adverse and rare occasions, particularly due to shock or vibration, the microswitch of the buckle switch becomes inoperative, thus cutting the camera off. By means of the override mechanism the cameraman in the field can quickly restart the camera without removing the camera door.

In case of doubt as to whether the buckle switch was unintentionally triggered by impacts or vibration, or whether it was actuated due to a film jam, it is recommended that the camera cover be opened to check the film path, sacrificing a few inches of film, rather than using the override control.

By pressing the push button below the viewfinder, the buckle switch override mechanism is actuated and the break in the circuit, due to the release or the malfunction of the buckle switch is bridged. To reset the buckle switch, the toggle lever of the buckle switch override mechanism is turned by hand to its initial position, interrupting its overriding function.

ARRIFLEX 16mm MOTION PICTURE CAMERA NOMENCLATURE

The extra long film gate (fig. 12-4) has an oversize rear pressure pad and a side pressure rail. It has cross stages around the picture frame both on the front and back plates making film breathing impossible. The film gate is made of stainless steel, chrome plated and lapped to high precision to prevent film scratching.

Registration Pin Film Movement

The registration pin (fig. 12-4) can be seen when the film gate is opened just above the transport claw. Its function is to locate the film precisely and hold it in place during the moment of exposure, thus insuring stable pictures, a perfect, precise frame line, and accurate trick and animation filming.

Film Transport Claw

The film transport claw (fig. 12-4) engages the film from the lens side, thus making loading easier. Its action can be watched by turning the transport knobs.

Magazines

The top of the camera accepts the 200- and 400-foot Arriflex magazines. A lighttight cover protects the magazine slot. When the magazine is attached, this cover must first be removed. The camera is ready for magazine operation and has internal wiring to actuate the extra takeup motor, needed with the magazine.

Supply and Takeup Spindles

Both spindles have an automatic detent lock to hold the film spools in place in any camera position. To take a film spool out, push down the button in the center of the spindle and tilt the camera sideways. Turning the knurled spindle disks on the outside of the camera, in the direction of the engraved arrows, takes up the film slack.

When the film is running, the spindles turn and thus indicate whether the film is running forward or backward (reverse). When the film has run off the supply spool its spindle stops turning, thus indicating that the supply spool is empty.

Tripod Sockets

Two tripod sockets, one American type and one European type, are located in the bottom of the camera housing.

Mirror Reflex Shutter

The mirror reflex shutter is the heart of the Arriflex. It rotates at a 45 degree angle between the lens and film plane and reflects upon the ground glass of the viewfinder exactly the same image that is registered on the film. (See fig. 12-6 and fig. 12-7.)

The light rays reach the film through the lens without any interference when the shutter is opened; they are reflected to the ground glass only while the shutter is closed. Thus the film, as well as the eye, always receives 100 percent of the light transmitted by the taking lens. The shutter opening of 180° results in the exposures indicated in table 12-1.

As table 12-1 indicates, the exposure can be calculated for any camera speed by doubling the fps figure and reading the result as a fraction of a second.

Lens Mount System

There are two types of mounts available for the 16mm Arriflex: the standard mount and the heavy-duty bayonet-lock mount. Each of the three turret lens positions on the Arriflex will accept standard Arriflex lens mounts. Its quick change simplicity and precision make it essential for fixed focal length lenses.

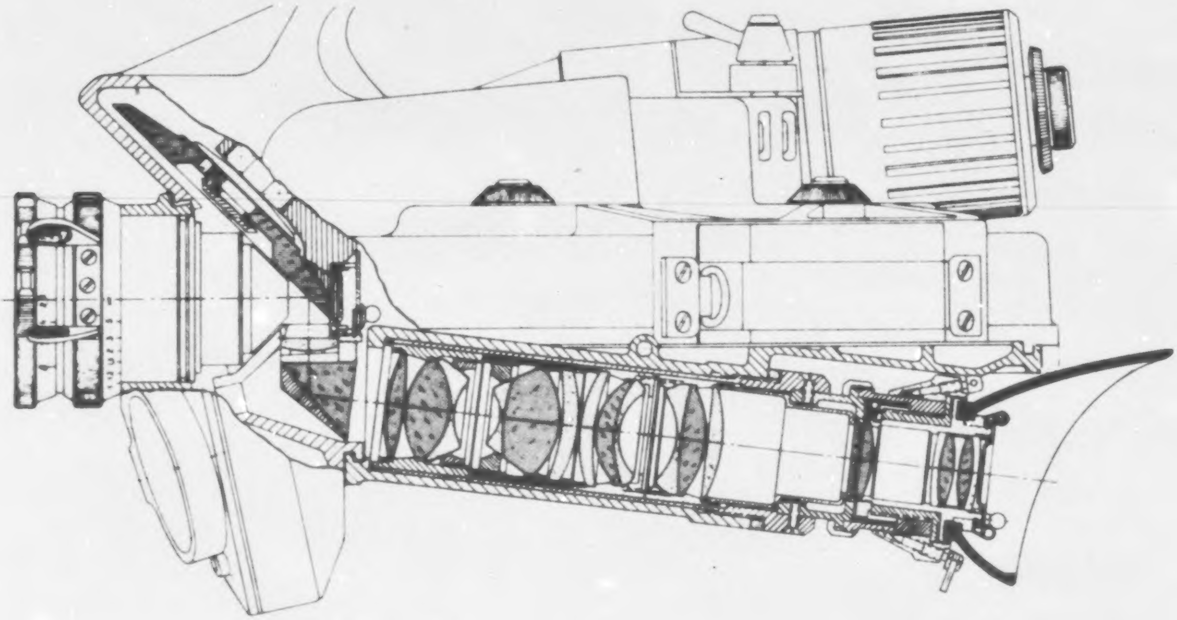

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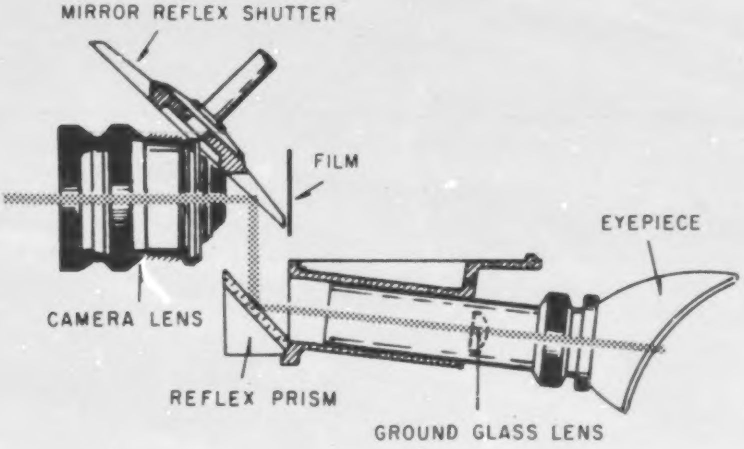
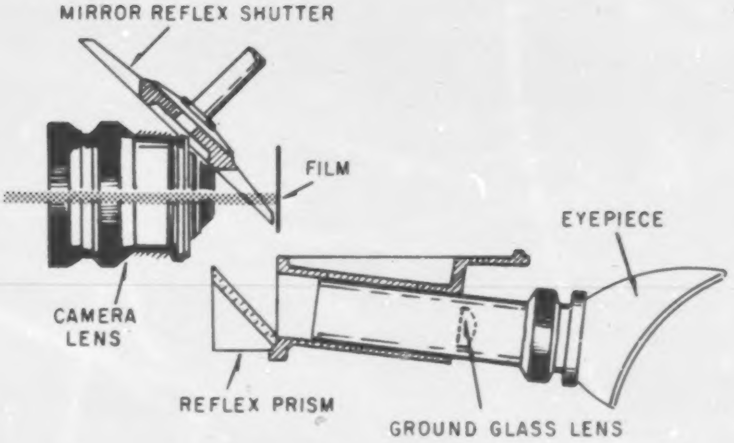
Figure 12-6.—Arriflex mirror shutter viewfinder.


MIRROR REFLEX SHUTTER
FILM
EYEPIECE
CAMERA LENS
REFLEX PRISM
GROUND GLASS LENS

SHUTTER 'CLOSED'—ALL LIGHT PASSES THROUGH THE VIEWING SYSTEM.


MIRROR REFLEX SHUTTER
FILM
EYEPIECE
CAMERA LENS
REFLEX PRISM
GROUND GLASS LENS

SHUTTER 'OPEN'—ALL LIGHT PASSES TO FILM.

PH.538

Figure 12-7.—How the Arriflex mirror reflex shutter works.

The heavy-duty Arriflex bayonet-lock mount was designed to accomodate the larger, heavier zoom lens. Lenses for use with the heavy-duty mount may be used only in the one special lens position of the turret equipped to handle the bayonet lock lens mount (fig. 12-8).

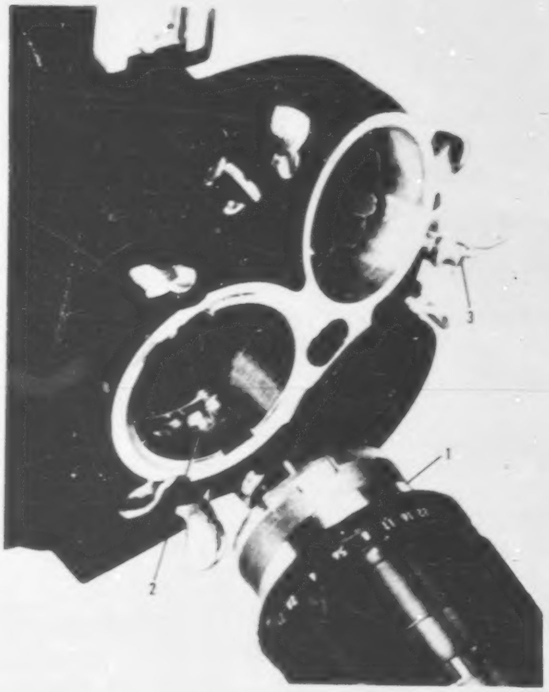
Divergent Three-Lens Turret

The Arriflex features a three lens turret. Lenses are mounted in the turret in a manner which provides a full 21° divergence between the three lens axes. This prevents optical and

Table 12-1.—Arriflex exposure table.

Camera Speed	Exposures
8 frames per second (fps)	1/16 sec.
12 fps	1/24 sec.
16 fps	1/32 sec.
24 fps	1/48 sec.
32 fps	1/64 sec.
48 fps	1/96 sec.

mechanical interference between wide-angle and telephoto lenses. Thus a 16mm wide-angle lens can be mounted simultaneously with a 300mm telephoto lens without danger of interference. The 300mm len's longer lens barrel will remain completely out of the wide-angle lens's field.



1. Heavy duty lens mount.
2. Matching camera lens socket.
3. Turret lock.

PH.547

Figure 12-8.—Heavy-duty bayonet-lock mount.

Three turret grips make it easy to rotate the turret which comes to a positive stop whenever a lens socket is over the film aperture. Do not grasp the lenses for the purposes of turning the turret around.

The lens located nearest the contour grip on the right side of the camera is in the taking position. The back of each grip, protruding from the left side of the camera and visible with the left eye while the right eye is looking through the finder, is coded with one, two, or three dots to indicate if the wide-angle, normal, or telephoto lens is in the taking position.

To remove the lens from the turret, press the two spring-loaded locking levers at the base of the lens socket together, with thumb and index fingers of one hand, while lifting the lens out with the other.

To insert the lens, again press the locking levers together and place the lens into the socket. Aline the channel in the lens mount with the guide key in the socket. Release the levers and the lens is locked into position.

LENSES FOR ARRIFLEX 16mm CAMERAS

The standard set of lenses and the ones most frequently used are the 16mm, 25mm or 28mm and 50mm focal lengths. These lenses also work best with the matte box.

When a longer focal length lens than the 50mm is mounted on the turret, the matte box often cannot be brought close enough to the 16mm or 25mm lenses to work properly. Therefore the longer lens must first be removed when using either the 25mm or 16mm lens.

When a lens socket is empty, it must be capped with a cavity cap which is supplied with the camera.

Extremely long or heavy lenses may require a cradle or other special support.

VIEWFINDER ACCESSORIES

The standard viewfinder eyepiece supplied with the camera has a manually operated hinged cover which, when closed, prevents any backlight from entering the reflex system of the camera. When the viewfinder is not in use during filming, the cover should be closed. The unit provides a diopter adjustment to compensate for personal eye acuity.

The periscope finder facilitates viewing from the top or the side in those situations where it is not practical to look into the camera eyepiece from the rear. Examples include situations in which the camera is on a microscope or copy stand or when shooting upwards from ground level. The optical system of the periscope finder consists of a roof prism and 10 lenses. (See fig. 12-9.) The periscope finder is attached to the camera between the finder and detachable eyepiece.

Three types of interchangeable ground glass are available. The standard viewfinder ground glass furnished with the camera shows the camera aperture, projector aperture, center cross for critical alinement, and "TV" safe action area. These three markings will enable the standard ground glass to be used for nearly all filming requirements.

Figure 12-10 illustrates the three types of interchangeable ground glass available.

The other two types of ground glass must be ordered special. One type equips the camera with a ground glass marked to show projector

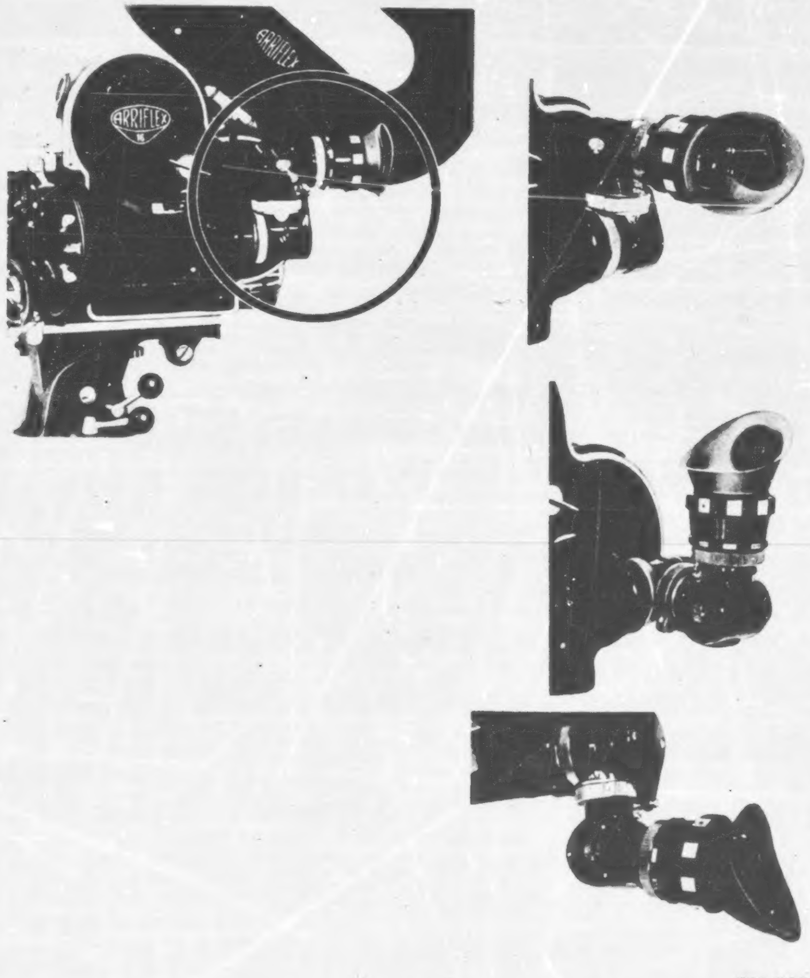


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Figure 12-9.—Arriflex periscope finder.

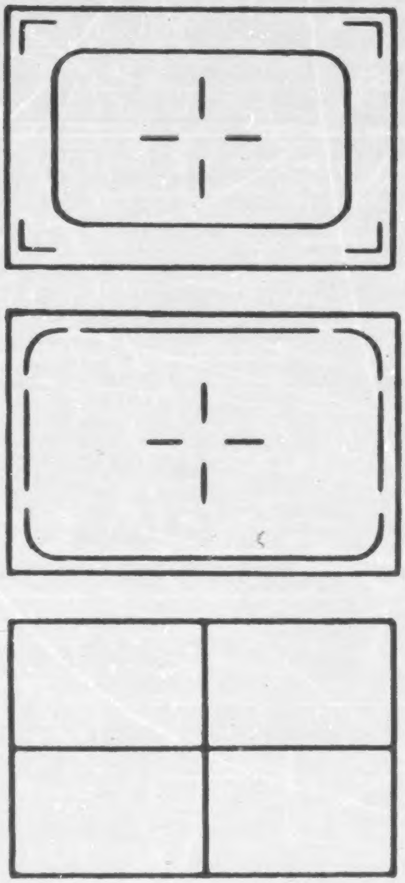

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Figure 12-10.—Interchangeable ground glass.

aperture and center cross only. The other special ground glass is clear glass etched with a center cross. This latter ground glass is designed exclusively for cinemicroscopy and other special work in which, because of high magnification, the grain structure of the ground glass makes viewing, focusing, and composition of the subject difficult.

Installation of the various ground glass screens is a job that requires skilled, experienced technicians with special tools.

ARRIFLEX MATTE BOXES

There are two types of matte boxes that can be used with the 16mm Arriflex, the standard model and the universal model.

The matte box serves as a lens hood, protecting the taking lens from stray light, and as a carrier for filter holders and filters. The matte box and a filter holder makes it possible to use only one standard size filter for many different lenses. The universal matte box, standard matte box, and filter holders are illustrated in fig. 12-11.

The matte box's rear standard is movable to accomodate lenses of various lengths. Its front is also adjustable to give maximum efficiency and to prevent vignetting irrespective of the lens used.

The standard matte box is recommended for all fixed focal length lenses in common use up to 75mm. The rear of the matte box has two stages for holding 60 x 75 x 3mm and 60 x 100 x 3mm filters or holders for 2 x 2 inch filters or gels. There are threads at the back part of the matte box for using Arriflex M58 x 0.75mm screw-in filters or adapters. Slide-in mattes for special effects can be placed in the front part of the matte box. Polarizing and graduated filters may be used in the rear stage, which can be rotated.

The universal matte box is intended to be used with the larger lenses, over 75mm in focal length, and the widely used zoom lens. Smaller focal length lenses can be used, however, by means of a small adapter in the rear stage of the matte box.

Standard Wratten filters 4 x 4 inches up to 10mm in thickness can be placed directly in the filter stage without the use of a filter holder. Two filter stages at the rear of the universal matte box will also accept any of the following filter sizes: 75 x 75mm Arriflex; 75 x 100mm Arriflex graduated filters; 94mm diameter polarizing filters; or 3 x 3 inch Wratten filters.

Installing The Matte Box

This indispensable accessory fits over the lens turret. To attach to the camera, slide the end of the boom into the special shoe on the front of the camera housing; then turn the knurled knob

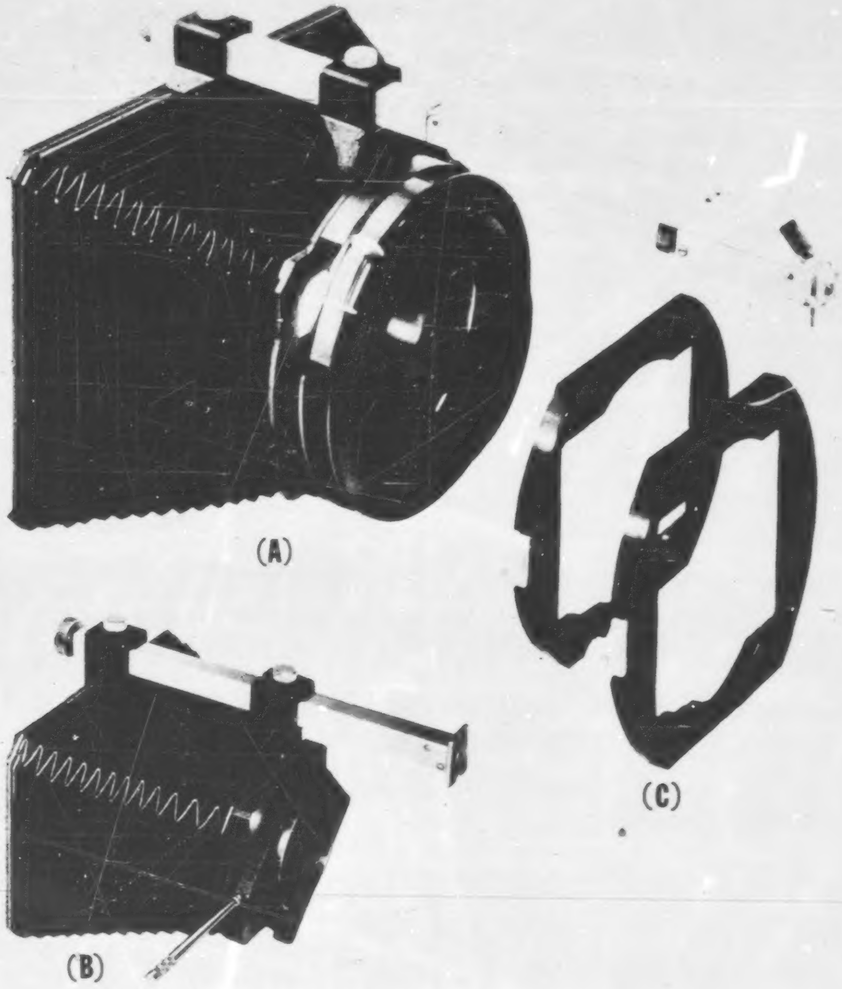

Figure 12-11.–Arriflex matte boxes and filter holders. (A) Universal matte box, (B) standard matte box; (C) filter holders.

at the front of the boom to tighten and lock the matte box into position.

ARRIFLEX MOTOR DRIVES

An 8-volt, d-c variable speed motor is generally used with the Arriflex 16mm. It is operated from an 8-volt battery or other adequate d-c supply. The variable speed motor contains a built-in rheostat to control the speed of the camera. When the motor is powered by the standard 8-volt Arriflex battery the frames per second range of the camera will be from approximately 6 to 40 fps. If the motor voltage is increased to 12 volts the frames per second rate will be increased to a maximum of 64 fps.

After the lock level is opened, the variable speed motor may be pulled out of the housing and interchanged with other motors, such as the 8-volt d-c, governor controlled, constant speed motor designed to operate at a fixed speed of 24 fps. The governor controlled motor will run forward only. Having a speed tolerance of ±1.5 percent, the governor controlled motor is perfect for applications where the camera is to be run at sound speed, 24 fps.

Synchronous Motors

There are two types of synchronous motors; the 42-volt synchronous motor and power supply combination, and the 117-volt synchronous motor. Motor speed for both the 42-volt and 117-volt synchronous motors is controlled by the 60 Hz line frequency. This results in an extremely accurate, constant 24 fps. Either type of synchronous motor is excellent for synch sound filming.

The lighter weight and more compact 117-volt synchronous motor is operated directly off a 117-volt 60-Hz single phase power source. The 8-volt d-c required for the magazine takeup and clapstick is supplied by a small module built into the back of the motor.

The power supply for the 42-volt synchronous motor must itself be operated off a 117-volt, 60-Hz single phase power line. The 42 volts power supply then provides the necessary step-down voltage to operate the 42-volt synchronous motor.

The 42-volt motor does not spark, making it ideal to use in an explosive atmosphere. The power supply for the motor must, however, be kept out of the danger area. The 42-volt supply also develops the required 8 volts d-c for the magazine takeup and for the automatic clapstick, and powers a dynamic braking system.

When replacing the variable speed motor, care must be taken to line up the locating pin against the keyway in the body casting and to push it all the way in; otherwise it will not make contact.

Turning the motor shell actuates a built-in rheostat that regulates the speed of the motor, which in turn can be read in frames per second on the tachometer. The figures around the motor shell are arbitrary ones, and after a little experience the operator is able to reset the camera quickly for any desired speed. (With a fully charged 8-volt battery the rheostat will normally be set between 3 and 4 to provide 24 fps.)

ARRIFLEX POWER SOURCES

Power to operate the 16mm Arriflex motion picture cameras can be obtained from an 8-volt, 4-ampere built-in rechargeable nickel-cadmium battery; an 8-volt/16-volt battery similar to the 8-volt, 4-ampere model but with twice the capacity; an 8.4-volt or 16.8-volt cine 60-battery belt which also contains a built in self charger; or from a regulated d-c power supply used to convert 117-volt 50- to 60-Hz single phase a-c power to d-c power.

The power requirements for an Arriflex with a 400-foot magazine are 8-volts d-c (under load); 3.6 amperes while running, with starting surges up to 6 amperes. It is important that the source of electrical power be fully capable of delivering this amount of current.

OPERATING THE 16mm ARRIFLEX MOTION PICTURE CAMERA

To hold the camera, when a tripod is not available or cannot be used, the following procedure is recommended. Place the thumb of the right hand between the contour grip and side of the camera, while the other fingers reach forward around the "bulge." In this position they are free to actuate the follow-focus grips and diaphragm ring of the lens in the taking position. Next place the palm of the left hand around the finder housing located on the left side of the camera, with the fingers over the on-off switch. With this method the camera can be held comfortably, easily, and will remain steady.

When the on-off switch is pressed down, it remains locked in the down position until its release lever is pressed in.

An accessory body brace, with or without a pistol grip, is also available. It is attached to the tripod socket and has its own release trigger (body brace with pistol grip model).

To sight the camera, place the right eye against the finder eye cup. For left eye viewing the eye cup may be turned around. If the shutter is closed, turn the transport knob in the center of the meter to open it. Next focus your eye to the ground glass by turning the knurled adjustment ring at the eyepiece until the grain structure of the ground glass appears sharp. You can do this without a lens in the socket. The adjustment ring should then be locked in place by either of the lock levers.

Next focus on the subject by actuating the focusing mount of the taking lens. For critical sharpness, always focus the lens with its diaphragm wide open. This is important to remember as the optical system of the Arriflex finder is so bright that a brilliant image can be seen even when the lens is stopped down. Most Arriflex lenses have clicking diaphragm stops so that the lenses can be stopped down audibly without removing the eye from the viewfinder. To place the f/stop ring in the click mode, a selector button must be positioned by sliding. This button is located on the f/stop ring. When a red "A" is showing, the clicking device is engaged. When the white "E" is showing, the clicking device is disengaged.

While the optical system of the finder is constructed so that it normally prevents light from entering and fogging the film, the eyepiece must be shielded from direct (horizontal) sunlight or powerful spotlights if the eye is removed from the eyepiece. During filming always press the eye firmly against the eyecup or close the light cover on the door.

An automatic closure eyepiece is available as an accessory on older cameras, or as an option with newer cameras. An internal automatic mechanism automatically opens the eyepiece when the eye is pressed against the rubber cup and closes it when the eye is removed.

ACCESSORIES

There are many accessories that are available for use with the Arriflex cameras, too many to go into detail on each in this chapter. Table 12-2 lists some and their uses.

MAINTENANCE

The Arriflex cameras are precision instruments and should receive the best care and maintenance. Any preventive maintenance or cleaning that may be required should be done with care, according to pertinent preventive maintenance instructions.

Some of the checks and their performance intervals are as follows:

1. Daily—Prior to operating the camera, always inspect the camera and accessories to insure that they are free of dirt, dust, and film chips.

After each roll of film check and clean the film gate, interior of camera, magazines, and air surfaces of all lenses.

2. Periodic—Clean all dirt and dust from the lens mount and sockets and relubricate with the special grease supplied with the camera.

3. After 30,000 feet of film has been run through the camera, oil the camera at the following points:

   a. One drop of oil, near the film gate.
   b. One drop of oil, near the spindle.

4. After 100,000 feet of film has passed through the camera, or after a period of 2 years, whichever comes first, the camera should be completely reserviced by one of the manufacturer's service departments.

MOTION PICTURE STRIKE CAMERAS, MODELS KB-19A AND B

The KB-19A and B are precision 16mm motion picture cameras designed and constructed to be used in fixed mounts in various naval aircraft. The camera is used for airborne combat documentation, and strike and gun recording photography. (See fig. 12-12 and 12-13.)

A description of the KB-19A and B models is provided in table 12-3.

SPECIAL FEATURES

The automatic exposure control (AEC) feature of the KB-19A utilizes scene brightness, frame rate (fps) and film speed input signals to energize the servomechanism. The servomechanism then sets the shutter selector opening to the correct exposure. The exposure lock feature incorporated retains the exposure at a fixed setting while the exposure lock-out feature will set the shutter opening two f/stops greater than normal or to the maximum position by means of samples taken of exposure settings. The AEC is accurate to a plus or minus 1/2 f/stop through an equivalent range of five f/stops and will operate through the entire f/stop range in a maximum time of 2 seconds.

Table 12-2.–Arriflex accessories and their use.

Accessory	Use
Single frame mechanism.	Adjust exposure interval.
Sound blimp.	Eliminate camera noise during filming a sound take.
Periscope finder attachments.	To provide offset viewing through viewfinder.
Handholding equipment: 1. Pistol grip. 2. Shoulder pad. 3. Combination of 1 & 2.	To steady camera during hand-held operation.
Tripod.	To provide a stable platform for camera.
Filter set (includes mattes, masks and filters).	Provides special effects exposure control and color correction.
Animation motor.	Animation photography.
Microscope connector.	Cinemicrography.
Underwater housing.	Underwater photography.
Auxiliary target finder.	For use with long focal length lenses.
Lens cradle.	To cradle extremely long lenses.

The KB-19B utilizes an iris exposure control mounted on the front of the camera to control the exposure. This control uses the scene brightness and film speed (ASA) to energize a servomechanism which sets the iris diaphragm.

The motor is mounted internally with a manual drive knob located on the rear of the camera to enable the film transport mechanism to be turned manually, when loading film. A shutter knob on the front of the camera allows the operator to manually control the opening of the variable disk shutter. The manual drive knob must be turned only in a clockwise direction.

The frames per second rate control of the KB-19A is located on the inner side of the camera body, beside the overrun control. To change the frames per second rate a special tool provided with the camera is required.

The overrun control permits the camera to continue operating for periods of 5, 10 or 15 seconds after termination of the run signal. An indicator light in the camera illuminates at the commencement of the overrun and remains illuminated until after the overrun is completed. A special tool is also required to set the overrun control.

The dynamically balanced film transport mechanism is mounted entirely on permanently lubricated ball bearings.

Should a film jam or overload occur, power to the camera is automatically secured by an overload protection switch. Power is cut off by an end of film switch, when the film in the magazine runs out or if there is a film break.

An inspection port on the magazine allows the magazine to be inspected while it is still on

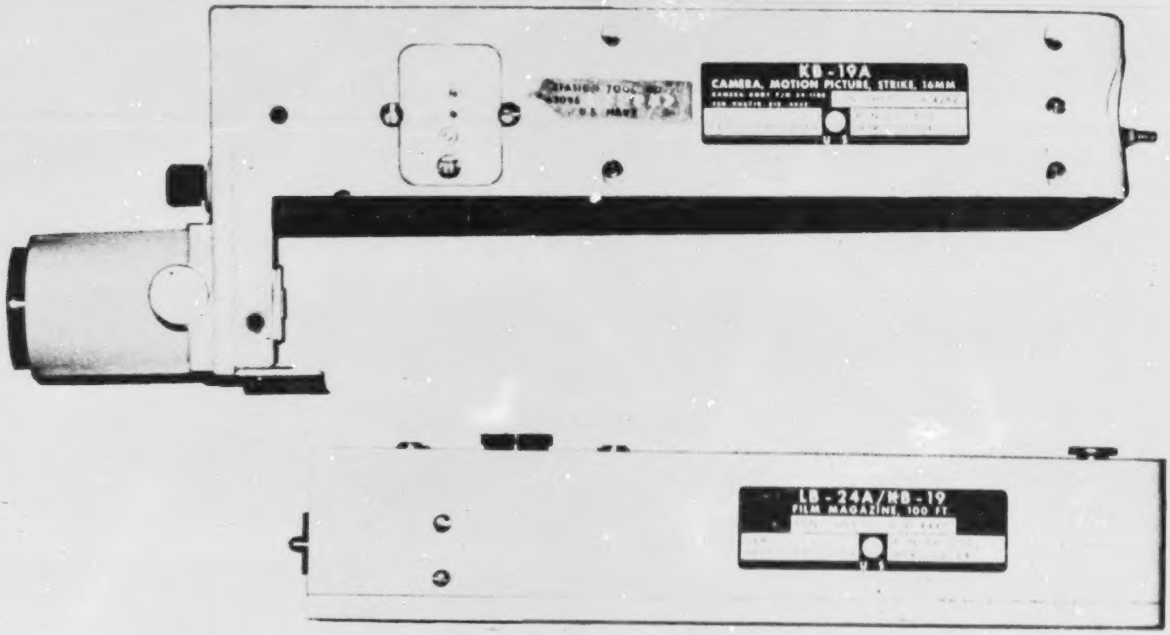

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Figure 12-12.—Side view of the KB-19A camera with magazine detached.

the camera. The inspection port is opened by pushing the cover lock button on the magazine down and then sliding it over approximately 1 1/4 inches to the first catch or inspection port position.

The automatic exposure control (AEC) is indexed by a selector button located on the inner side of the film magazine.

The camera is mated to the camera pod by a dovetail plate which also alines the camera in respect to the window in the pod. Mounting provisions consist of three threaded holes which accept 10-32 NC-2 fasteners.

The camera is boresighted by means of a boresighting tool attached to the camera in place of the film magazine. The boresighting tool is positioned approximately 7/16 of an inch back from the aperture in two positions. One position is in line with the lens and the other is at a 90° right angle to the lens. The camera's full field of view, including the fiducial marks, can then be observed at a 10 power magnification. A periscope finder is used to observe the field of view at the 90° angle.

LOADING THE KB-19A MOTION PICTURE STRIKE CAMERA

Remove the magazine from the camera by unlocking the locking mechanism. (As indicated by the arrow on the locking device, depress the pen and turn counterclockwise to lock.) The magazine has two positions when being removed, as follows:

1. The first position is the inspection port position previously mentioned. Depress the cover lock button on the magazine and slide it over to the first catch (approximately 1 1/4 inches).

2. The second position is the full or off position. Press down on the rear of the cover and slide it off to have access to the film chamber. Before installing a loaded spool of film make certain that the film supply indicator has

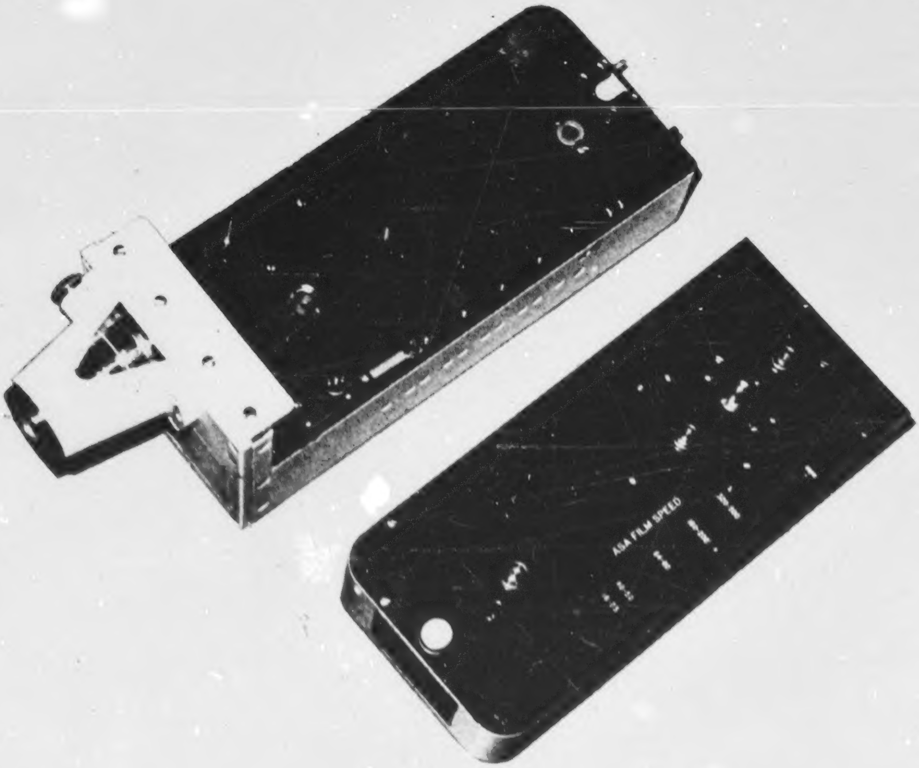

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Figure 12-13.—Interior view of the KB-19A camera and magazine.

been rotated to prevent damage to the supply spool or to the indicator arm; failure to do this will result in the film feeding improperly and jamming.

Cut the film to be loaded square across the perforations. Place the film on the supply shaft with the film emulsion side in and feeding off clockwise. Depress the detent button, while holding the indicator arm out of the way and push the supply spool into the latch detent. The detent buttons have spring-loaded ball bearings that will release when pushed: their purpose is to hold the film spools/reels in place.

Manually pull several inches of film off the supply roll and feed it over the guide rollers, then forward over the keeper roller until it touches the upper sprocket. Push the film into contact with the upper sprocket and rotate the drive gear. Continue rotating the drive gear, causing the upper sprocket to rotate in a clockwise direction. This will push the film up past the forward guide roller and on through the film gate. Loop the film back and into the film gate at the bottom of the aperture opening.

Guide the film until it touches the pull down pins and rotate the mechanism while manually pushing film into the gate, following the pull down pins. Line up perforations in the film with the registration pins. Observe that the upper film loop is as low as possible without being tight. Rotate the drive gear until the film moves down through the gate and appears at the bottom.

Fully depress the loop forming button on the bottom of the camera and continue rotation of

Table 12-3. Motion Picture Strike Cameras KB-19A and B.

	KB-19A	KB-19B
Focal length lens	75mm fixed focus.	same
Lens mount	C mount/f stop lock.	same
Max. aperture	f/2.8	same
Cycling rates	24, 36, 48, 64, 128, 200	48 only
Film magazine	LB-24A	same
Film capacity	100', 200', 400' of double perforated 16mm film.	same
Number of exposures per 100' magazine	4000	same
IMC rate	None	none
Body	LB-28A	LB-28A
Shutter type	Variable rotary disk, 5° min., 160° max. shutter opening.	Fixed rotary disk, 60° shutter opening.
Filters	Clear, red, yellow. Screw-on type.	same
Controls	Frames per second and overrun.	Overrun and exposure lock.
Power requirements	115 VAC, 420 Hz single phase, 575W, 25 to 28.5 VDC, 120W.	same
Camera pod mounts	LB-18A, LB-30A, LB-31A, LB-33A.	same
Applicable test sets	None	none
Overrun settings	0, 5, 10, 15 seconds.	0 and 10 seconds
Exposure control	Automatic (AEC)	Iris
Operational temperature	−65° F to 120° F.	same
Heater	115 VAC, 300 watts. Rheostatically controlled. Energized when aircraft receives power.	same
Film footage indicator	Subtractive type accurate to plus or minus 10 percent.	same

the drive gear. Hold the loop former button in until the film tracks into the sprocket. The film will automatically track around the lower sprocket and into the takeup area.

Continue to rotate the drive gear until sufficient film is available to attach it to the takeup spool. Then attach the film to the takeup spool.

Place the takeup spool on the takeup shaft so that film feeds onto the takeup spool in a clockwise direction. Depress the detent button and push the spool into the latch detent. Using your fingers, grip the takeup spool and lift up on the magazine to insure that the spool is locked into place. Rotate the takeup spool until all slack is removed from the system. Check that no film loops touch the walls of the camera. Replace the magazine cover.

Install the ASA film button in the ASA position that corresponds to the rating of the film being used. To establish the correct ASA to f/stop relationship use the chart on the end of the magazine. The magazine is now ready for use.

MAINTENANCE

Prior to loading film, check and clean the interior of the camera and magazines, film gate, and air surfaces of lenses. Lubricate the registration pins weekly with a thin film of MX 80 or MX 90 oil.

Using a cloth dampened with a solution of 50 percent grain alcohol and distilled water, remove any oily film, grease, or dirt from the rollers. Do not use any cleaning solvent on the shutter blades or any electrical component.

Until you are positive that all electrical power is off, consider all electrical equipment as being energized.

The technical manual, NavAir 10-10-AC-115 should be consulted for any additional information.

HIGH-SPEED MOTION PICTURE CAMERAS

High-speed motion picture photography is used in various ways in the Navy, a few of which are listed below:

1. Photographing guided missiles and rockets.
2. Photographing high-speed moving parts, such as aerial camera shutters, aircraft and aircraft components, explosion phenomena.
3. Medical research.
4. Parachute testing.
5. Strength of materials.
6. Vibration studies.
7. Wind tunnel tests.

High-speed motion picture photography is used extensively at the various guided missile test centers throughout the United States. A typical center is the Naval Weapons Center, China Lake, California. Its primary function is the development and testing of weapons, particularly those in the fields of rockets and guided missiles. Located west of Death Valley in California's Mojave Desert, the 800-square mile expanse of desert and mountains that contains the principal test ranges was selected not only for its isolation but also for its excellent visibility conditions, for the vast bulk of information obtained from these test firings is photographic in nature.

An amazing variety of cameras is used by the test station to furnish precise photographs denoting velocity, acceleration, range, altitude, spin rate, and other data that are the basis of any scientific evaluation and improvement program.

High-speed motion picture photography projected at normal frames per second rates (24 fps) or if required slower fps rates, extends the audience's viewing time of an event which could originally have taken place in only a fraction of a second. This allows the event to be studied, measured, or analyzed.

Many types of cameras and specialized equipment are utilized by the Navy in this field of photography.

1. Normal motion picture cameras with high speed motors; for example, the Milliken DBM-4; DBM-5B and DBM-5C.
2. High speed cameras using continuously moving film and rotating prism for example, the Fastax.
3. Image dissecting cameras.
4. Rotating mirror framing cameras, having framing rates up to 10 million frames per second.

5. Electronic cameras using pulsed tubes to provide a framing rate of 1 billion fps.

It is not within the scope of this rate training manual to fully cover the highly specialized field of high-speed cinematography. Therefore the remainder of this section will be limited to a discussion of high speed motion picture photography by means of normal motion picture cameras using high speed motors.

These type cameras employ intermittent film movement and mechanical shuttering and are limited to a maximum frames per second rate (fps) of about 500 fps for 16mm film. This is due largely to the physical strength of the film. Starting and stopping the camera at high fps rates creates stress on the film which can cause the film's sprocket holes to tear or even possibly exceed the breaking point of the film.

TIMING

The film used in motion picture cameras at high fps rates is often still accelerating when the film magazine becomes empty, never having achieved a steady velocity.

Small marks referred to as timing marks are recorded at regular time intervals along the edge of the film outside the picture area. These marks assist in determining the actual velocity of the film at any point during the exposure.

The length of the mark on the exposed film will vary with the speed of the film and the frequency of the light. The latter may be controlled directly from a stable 120-volt, 60-Hz line producing 120 flashes per second–equivalent to a time interval of 0.00833 second between the start of successive flashes. The frequency of light can also be maintained at 1,000 flashes per second by a special oscillator which operates on 120 volts a.c. (60 or 400 Hz).

In either case, the time interval between the start of each flash divided by the number of intervening frames will give the time between exposures. For example, when the timing light is connected directly to a 60-Hz line and there are 33 pictures between starts of 2 timing marks, divide the number of pictures by the time interval, 0.00833, to obtain the camera speed, or 4,000 pps. To determine the time between individual frames, divide the time between flashes, 0.00833 by the number of pictures between flashes, 33, arriving at an interval of 0.00025 second.

MILLIKEN HIGH SPEED MOTION PICTURE CAMERAS

The 16mm Milliken high speed motion picture cameras are designed to provide motion pictures at rates as high as 500 fps even under severe environmental conditions. An intermittent movement with register pin stops the film and locks it during exposure. The movement describes a circle with film movement only intermittent. As a result the high-inertial loads that normally wear down high-speed cameras are completely eliminated. Modular construction permits complete removal of the operating mechanism to facilitate cleaning and servicing. (See fig. 12-14.)

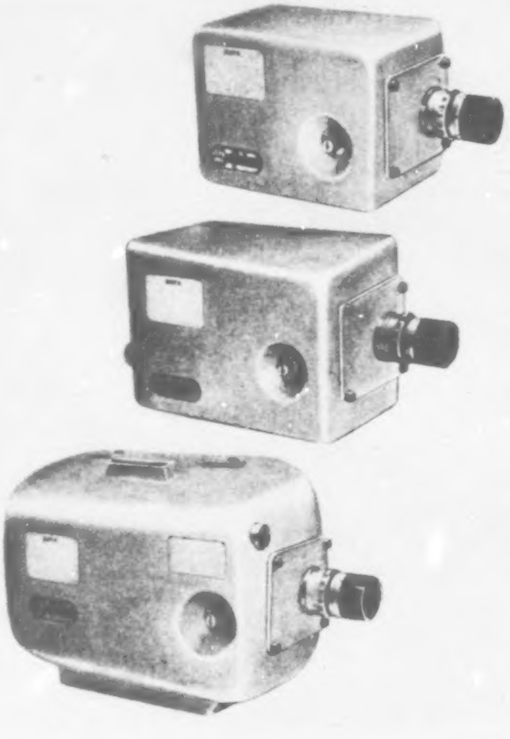

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Figure 12-14.–16mm Milliken motion picture cameras, models DBM-3; DBM-4; DBM-5.

A description of the DBM-3, -4, and -5 series cameras is as follows:

1. Focal length of lens: 25mm standard or a variety of lenses in standard "C" mounts can be used.
2. Maximum aperture: f/2.
3. Angle of view: 25mm lens, 37° x 44°13'.
4. Cycling rate with high speed motor: 64, 128, 200, 400 fps or 64, 128, 250, 500 fps.
5. Film magazine: none; film internally loaded.
6. Format size: standard double perforated 16mm.
7. IMC rate: none.
8. Shutter type: Rotary disk, disk with 70° opening furnished with camera, other disk openings available.
9. Power requirements: DBM-3, 28 VDC, 7.5 amps; DBM-4 and -5, 28 VDC, 9 amps; DBM-3, -4, and -5 115 VAC, 3.8 amps.
10. Mount: Dovetail plates on camera can be used for mounting camera in aircraft pod or blister.
11. Applicable test sets: none.
12. Camera speeds with high speed motor: 64, 128, 250, 500 fps.
13. Shutter speeds: from 1/9 to 1/24,000 seconds.
14. Footage indicator: Automatic resetting.
15. Current consumption: 8.5 amps d.c. at 500 fps; 3.8 amps a.c. at 500 fps.
16. Lens: 25mm f/2.0.
17. Lens mount: C mount standard.
18. Cutoff switch: Heavy duty microswitch automatically stops camera at end of film run.
19. Timing lights: NE-2j high-brightness neon lamps.
20. Correlation pulse generator: Produces an output pulse at a frequency synchronous to the camera shutter.
21. Standard shutter opening: 70°.

Cameras that carry the letter C in the model number (for example, the DBM-4C) are capable of operating at cycling rates from 4 to 400 fps.

DBM-5 series cameras with a D added to the model number (for example, the DBM-5CD) will operate at cycling rates from 4 to 500 fps.

The letter M added to the model number (for example, the DBM-4CM) indicates a magazine adapted camera which will accept as an accessory a 1,200-foot film magazine.

Operating Principles and Preloading Instructions

The following steps should be taken to become familiar with the principles of operation and preloading operations.

1. Move the shuttle to its fully retracted position by rotating the inside threaded knob clockwise.
2. Carefully remove the film guide assembly by unscrewing and lifting the two knurled knobs.

CAUTION: Make certain that the guide does not contact the shuttle tips during removal; handle the removed guide with care to avoid nicks and scratches.

3. Rotate the threading knob slowly. Notice that the register pin retracts from the film plane just prior to the entry of the shuttle tips. The register pin holds the film stationary during exposure and releases the film just before the shuttle tip enters to advance the film to the next frame. This pin-register movement which locks each frame during exposure insures pictures of exceptional clarity and detail. The position where the register pin has retracted and the shuttle tips are about to enter is the loading zone. This position will be further described in the loading instructions.
4. Notice the four gate buttons on the inner surface of the removed film guide assembly. These buttons hold the film flat during exposure. They are adjusted at the factory to accept standard acetate-base film. If the camera is to be operated with thin-base film it will be necessary to readjust the gate buttons for this type of film. To prevent mismatching, the aperture and film gate of each camera is serialized.
5. Replace the film gate assembly.
6. Examine the takeup spool intended for use. It should not be bent or allowed to bind in any manner.

Loading Instructions

Place the camera on its side with the lens facing left. Transmission-equipped cameras should be shifted to neutral prior to loading.

1. Remove the takeup spindle.
2. Retract the footage counter arm by rotating the tab on the periphery of the graduated footage scale.

3. Place the film load on the feed spindle engaging the square hole of the spool over the square shank of the spindle. Make certain that the spool will rotate clockwise when film is drawn from it. Film should be wound "emulsion in" on the supply spool.

4. Release the footage counter tab.

5. Replace the spindle on the spool shaft. Applying a light coat of silicon lubricant on the shaft will allow the spindle to freely slip on and off.

6. Unreel about 18 inches of film from the supply spool. Rotate the shuttle to its fully retracted position.

7. Open the film sprocket guide by pulling the film guide plunger up and rotating the guide away from the sprocket.

8. Thread film clockwise around the brake roller arm.

9. Wrap the film counterclockwise between the timing lamp housing and guide roller, then clockwise around the film sprocket.

10. Snap the feed sprocket guide shut.

11. Rotate the threading knob at least two full turns to verify proper threading.

12. Return the shuttle to its full retract position.

13. Open the film tension rail by depressing the extended rail arms fully towards the camera mechanism plate. Lock the tension rail open by sliding the rail assembly toward the top of the camera.

14. Form the counterclockwise feed loop to size slightly larger than the white line on the pin drive cover. Insert the film between the two guide posts and into the gate. Because the register pin is in the film plane when the shuttle is fully retracted, the film will be prevented from seating properly in the gate at this time.

15. Press on the rear of the shuttle to rotate it counterclockwise until the shuttle tips just touch the film. At this position the register pin is retracted and the film can be seated in the gate.

CAUTION: Too much pressure can dent or bend the film causing it to bind in the gate.

16. Press on the edge of the film at both sides of the gate and slide the film forward and backward to seat it in the proper film plane.

17. Unlock the tension rail permitting it to rest on the edge of the film.

18. Starting with an oversize film loop, slowly pull on the free end of the film until the correct loop size is reached. At the same time apply very gentle forefinger pressure on the end of the shuttle in a counterclockwise direction.

19. At or near the correct feed loop size, the film perforations will line up with the shuttle tips and the shuttle will advance into the film perforations.

20. Rotate the threading knob clockwise several times to verify proper operation. This operation also clears the gate of any possible dented film areas.

21. Leave the shuttle fully engaged.

22. Open the lower takeup guide by pressing its toggle arm toward the door side of the camera.

23. Form the counterclockwise takeup look and slip the free end clockwise between the upper takeup sprocket and its guide to a position between the lower takeup sprocket and its guide. As this step is performed, the cutoff switch arm will automatically be depressed.

24. Snap the lower guide shut by pressing its toggle arm toward the front of the camera.

CAUTION: Make certain the guide does not overtravel its locking position and bind on the sprocket.

25. Check the lower loop to verify the following:

a. Loop size is equal to the white line.

b. The film is holding the limit switch arm down.

c. The sprocket is properly engaged in the perforations. Rotate the threading knob to verify proper operation.

26. Form the film in a clockwise spiral climbing loop up through the upper takeup sprocket and its guide. Size the loop to correspond with the white line. Snap the guide shut by depressing its toggle arm.

27. Pass the film counterclockwise around the last roller (and clutch roller on the DBM-5 model).

28. Rotate the threading knob several times.

29. Wind the film "emulsion in" on the takeup spool so that clockwise rotation of the spool will take up the film.

30. Engage the spool on the square shank of the takeup spindle.

31. Remove the bulk of the slack by holding

the threading knob secure and rotating the takeup spool clockwise.

CAUTION: Remove the remaining slack by rotating the threading knob clockwise. There must be absolutely no slack between the last roller and the takeup spool.

32. Rotate the inside threading knob until the shuttle is fully engaged. This is the "film locking zone" as indicated by the arrow on the outside threading knob. With the shuttle fully engaged, the film is locked into place. To insure against any shifting of the film the outside threading knob should be positioned in the "film locking zone" when the camera is being transported and just prior to operation.

33. Replace the door and rotate the locking knobs until the door is secure.

Milliken Camera Controls

There are three controls on the DBM-4 and DBM-5 cameras; these are the footage counter, speed switch, and outside threading knob.

FOOTAGE COUNTER. The footage counter on the back of the camera indicates the number of feet of film remaining on the supply spool. The counter is an automatic resetting type and does not require any manual manipulation.

SPEED SWITCH.—The speed switch is also located on the back of the camera. It enables the selection of two speeds by switching separate sets of contacts in the motor governor.

With the camera door and film spools removed, a motor label is exposed through the gear plate opening. This label shows two speeds available with the motor installed in that position (the motor can be installed in two positions). Turning the speed switch to slow will operate the camera at the lowest frame rate shown on the label. Setting the switch to fast will run the camera at the high rate. The speed switch can be used to change speeds while the camera is operating. When the motor is rotated to change the gear ratio, another motor label will be exposed indicating two new speeds available.

CHANGING THE FRAME RATE.—All 115-volt a-c and 28-volt d-c motors available for the Milliken cameras are capable of operating the camera at four speeds. Speeds are determined by setting the speed switch and/or changing the gear ratio. For example: The frame rate of the high speed motor (64, 128, 200, 400 fps) may be changed from 128 to 400 fps by turning the speed switch. To operate at 64 or 200 fps, it will be necessary to rotate the motor and change the gear ratio which, when accomplished, will allow changing the frame rates from 64 to 200 fps by means of the speed switch.

OUTSIDE THREADING KNOB.—If the camera has been stored with film loaded for any length of time, it is a good practice to rotate the knob several times to verify proper threading before the camera is operated. To prevent accidental shifting of the film in the gate, always leave the arrow on the knob pointing to the "film locking zone" after the camera has been loaded.

Boresights

Two models of boresights provide through-the-lens viewing for accurate composition and focusing. The right angle model is capable of being swiveled 360° for sighting from any position. High quality optics provide variable magnification from 10- to 25-power on the right angle model and from 10- to 30-power on the other boresights. The entire format (field) is visible at low power; high power is used for critical focusing.

BORESIGHTING THE MILLIKEN CAMERAS.—To boresight the cameras proceed as follows:

1. Remove the camera door.
2. Remove the film guide assembly by unscrewing the two knurled knobs located near the front of the camera.

CAUTION: Make certain that the shuttle is fully retracted before attempting to remove the film guide assembly. Handle the removed guide with extreme care to avoid nicks and scratches.

3. Open the feed sprocket film guide.
4. Install prism assembly.
5. Open the lens to its widest aperture.
6. Install the boresight and proceed with the camera alinement.

NOTE: The boresight prism has an etched surface to simulate the film plane. It is not necessary to use frosted glass when boresighting with the Milliken camera.

CAUTION: When boresighting with the right angle model make certain to focus on the etched surface of the prism assembly installed in the gate, and not on the prism inside the boresight.

7. To cover the camera's entire field of view, adjust to low power as follows:

a. Loosen knob farthest from the eyepiece.

b. Extend boresight to full length and tighten knob.

c. Loosen knob nearest eyepiece. Adjust to bring frosted etching on prism in focus and tighten knob.

d. Adjust focus ring on camera lens to focus image.

8. For critical focusing, adjust to high power as follows:

a. Loosen both knobs.

b. Extend boresight to full length and tighten knob nearest eyepiece.

c. Gently slide boresight closed until it stops.

d. Tighten knob farthest from eyepiece.

e. Loosen knob nearest eyepiece. Adjust to bring frosted etching on prism in focus and tighten knob.

f. Adjust focus ring on the camera lens to focus image.

Maintenance

Preventive maintenance check list procedures should be performed at regular intervals. The following paragraph outlines the steps in the recommended procedure. The first steps, inspection and cleaning, should be performed after each roll of film has been run through the camera.

INSPECTION.–Before the camera is used, the shuttles and register pin should be checked daily for burrs, nicks, and alinement. The camera mechanism should be checked for loose assemblies, screws, or retaining rings.

CLEANING.–Remove excess grease, oil, film chips, and other foreign material from the gear train, gate area, and housing.

Use the gate brush, Q-tips, and toothpick to clean shuttles and gate of emulsion buildup.

Clean the register pin clearance hole. Remove the lens plate, shutter, and film guide. Rotate the threading knob to retract the register pin. With the shutter removed, the clearance hole is visible through the lens opening. Use a toothpick to clear the hole.

LUBRICATION.–The camera should be lubricated in accordance with the manufacturer's operating and service manual. Lubrication is accomplished after each 5,000 feet of film has passed through the camera at 200 fps and above, or after each 10,000 feet of film has been run at speeds below 200 fps.

Exposure

Because of the varying conditions under which high-speed motion pictures are made, the factors influencing lighting and exposure are listed in principle only. At the exceptionally short exposures per picture necessary in high-speed motion picture photography (1/15,000 second at 3,000 frames per second), the main problem is to get sufficient light on the subject. Generally speaking, the amount of light required is dependent upon the following: speed of film, picture frequency or camera speed, size of diaphragm opening, and color of subject.

Because of the high light values employed in high-speed photography, it is difficult to determine exposure accurately without the use of a light meter.

1. RECOMMENDED ARTIFICIAL LIGHTING. When available, tungsten-filament sunspot lamps, focusing spotlights, or focused keg lights are preferable. Such lights deliver a concentrated intensity of light and can be set up some distance from the subject. This makes it possible to place the camera near the subject and has the further advantage of decentralizing the generated heat.

Floodlamps, such as the RFL2, the RSP2, and the more powerful G.E. 750R40, are convenient for lighting small areas. They have a color temperature of 3200°K which is suitable for black-and-white film or tungsten type color film.

2. ANGLE OF LIGHT. Whenever possible, place the lamps close to the lens axis, in which

position they produce the greatest amount of illumination on the subject.

Position the lamps, then turn them on individually, concentrating the beams on the required part of the subject. From a position near the camera lens, check to see that there is no disturbing specular reflection from any part of the subject. If greater contrast is necessary, move one group of lights away from the axis, observing the subject from a point near the camera lens.

3. DETERMINING CAMERA SPEED. Closely dependent upon the intensity of light necessary to secure good pictures, is the picture frequency necessary to slow up the action sufficiently. If the shutter allows light to pass during about one-fifth of the time of each picture cycle; the actual exposure time is the reciprocal of the number of exposures per second multiplied by five. For example, at a camera speed of 2,500 frames per second the exposure for each frame is about 1/12,500 second, and at 1,000 frames per second, about 1/5,000 second. Avoid using camera speeds higher than necessary. Several factors must be taken into consideration in selecting the most suitable picture frequency.

Action time is limited by the number of frames available on the film being used; i.e. 4,000 frames on 100-foot rolls. If a picture is taken at a terminal speed of 1,000 frames per second, an action lasting 3 1/2 seconds can be recorded on a 100-foot roll. The balance of the film is used for acceleration.

Speed of the subject is even more important than action time in selecting the required picture frequency. To figure the picture frequency necessary for any given motion, use the following formula:

$$\text{Picture frequency} = \frac{40 \times \text{speed of subject in inches per second}}{\text{Total width of subject field in inches}}$$

Example: Subject movement 75 feet per second or 900 inches per second.
Width of field covered by lens 15 inches.

Therefore:

$$\frac{40 \times 900}{15} = 2{,}400 \text{ approximate picture frequency}$$

The above formula is based on the assumption that the subject moves parallel to the film. A change in the direction of the subject's movement, in relation to the film plane, results in a motion that appears slower. The extent of this apparent slowdown depends upon the angle between the path of the subject and the film plane. If these two are nearly parallel, the slowdown is small, but if the subject travels directly toward or away from the lens, very little image shift takes place.

SOUND RECORDING AND REPRODUCTION

Motion picture cameras that have either a built-in or connected provision for the recording of sound effects or commentary are termed sound cameras. Sound can either be recorded directly on the film exposed in the camera, by means of a magnetic sound strip on the film, or indirectly by means of a tape recorder coupled to the camera.

The four major types of recording systems are disk, optical, magnetic strip, and magnetic tape. Of these methods the best sound quality is obtained from the usage of tape recorders and 1/4 inch magnetic tapes. For this reason only the double-system recording system will be presented in this chapter.

SOUND SYNCHRONIZATION

When tape is used for the recording of sound it becomes necessary to adopt some method of keeping the film framing rate and tape speed in precise synchronization. Of the various sytems in use, "pulse synchronization" is the principal method used in naval motion picture photography. A special synchronizing signal is recorded as a separate track on the tape, at the time of filming. This synch signal voltage of 1.0 to 1.25 volts a.c. at 60-Hz or 2 1/2 Hz for each picture frame at 24 fps is standard throughout the world, and is the correct voltage to use on transistorized recorders such as the Nagra.

Two methods presently used in the U.S. Navy for recording a synchronization (pilot) signal on 1/4-inch tape (audio track) are the Neo-Pilottone and Ranger systems. These two systems are compatible.

The Neo-Pilottone system uses high frequency bias available only on the Nagra recorders. The sync signal normally used is 60 Hz. This signal is recorded directly down the center of the audio track and requires a special record head which follows the audio recording head to be recorded.

The special record head is composed of two standard type magnetic heads separated by about 18mm. These heads are in line with and parallel to the audio head and positioned in such a manner as to record down the center of the tape. To give a minimum of crosstalk the heads are balanced in a push-pull mode of operation.

The Ranger system also uses a 60 Hz sync signal recorded down the center of the audio track.

A synchronizing head located after the recording head makes a recording 25 to 30mm wide down the center of the magnetic tape (this is also the center of the audio signal).

The narrow slit of the head is placed almost at right angles (5 degrees off 90 degrees to provide a wider sync recording signal and thus minimize trouble due to tape weave). This design effectively places the sync signal in a push-pull mode of operation with respect to the audio signal.

The audio signal is in effect erased in the area of the tape utilized by the synchronizing (pilot) signal. A 470mm audio sound track is thus reduced to about 440mm. This reduction, however, does not affect the signal-to-noise ratio enough to be of any consequence.

The two basic systems of motion picture sound recording are single-system and double-system.

Single-System Sound

Used principally in news work or uncontrolled action situations, single-system sound is complete. The sound track is recorded directly on the film in the camera either magnetically or optically.

Double-System Sound

The method with which we are primarily concerned is double-system. Double-system means that the camera and tape recorder are separated and synchronization maintained by either mechanical or electrical means. There are a number of ways to accomplish this.

The principle involved in a typical setup for recording with a 1/4-inch tape recorder in synchronization with a motion picture camera is based on the use of two synchronous motors. A 1/4-inch synchronous recording requires two tracks on the recorder. This requirement is met by any stereophonic recorder.

Suppose that a picture is being taken with a camera driven by a synchronous motor. A 60-Hz pulse at 110 volts a.c. is driving the camera's synchronous motor. The speed of the motor is thereby determined by the pulse rate of alteration of the current. If the speed of the pulse should vary, the speed of the motor will also vary. Because of the varying speeds of the camera motor and tape recorder motor, and also because the magnetic recording tape will slip and stretch, if sound was recorded it would be out of synchronization with the picture within a few seconds.

Because the tape slips and stretches and the film doesn't, information regarding the speed of the camera motor has to be recorded on the tape at the same time as the sound. This information is provided by the 60-Hz alternating current driving the camera's motor. All that is needed to provide information regarding the camera motor speed is to record the 60-Hz pulse on a separate track of the tape. However, tape recorders cannot accept a signal of 110 volts. So the current must be transformed to an acceptable voltage (synch signal voltage of 1.0 to 1.25 volts a.c. at 60 Hz).

If the picture is photographed with a camera fitted with a synchronous motor, the sound is recorded by means of a 1/4-inch tape recorder equipped with two recording heads and the pulse rate of the alternating current is recorded on the second head through a transformer, achieving synchronous sound recording. The use of a clapstick marker at the beginning of each take allows for the two motors reaching speed at different rates.

This system has so far described an a-c synchronous motor. However in many situations a d-c camera motor would be more desirable, but there is no pulse involved in driving a d-c motor, hence no pulse to record on the magnetic tape.

It is possible however to mechanically supply a pulse when using a d-c motor. Inside the camera there are a number of shafts turning between the camera and the movement, in addition to the shaft in the center of the motor. All that is necessary is to attach one of these shafts to a generator. Through the use of gears the generator is made to turn at the proper number of revolutions, in order to yield a 60-Hz pulse when the camera is operating at 24 fps. Since the shaft used to generate the 60 Hz pulse rate is either the motor shaft itself or one attached to it, any variation in camera motor speed will be reflected by the generator and recorded on the tape.

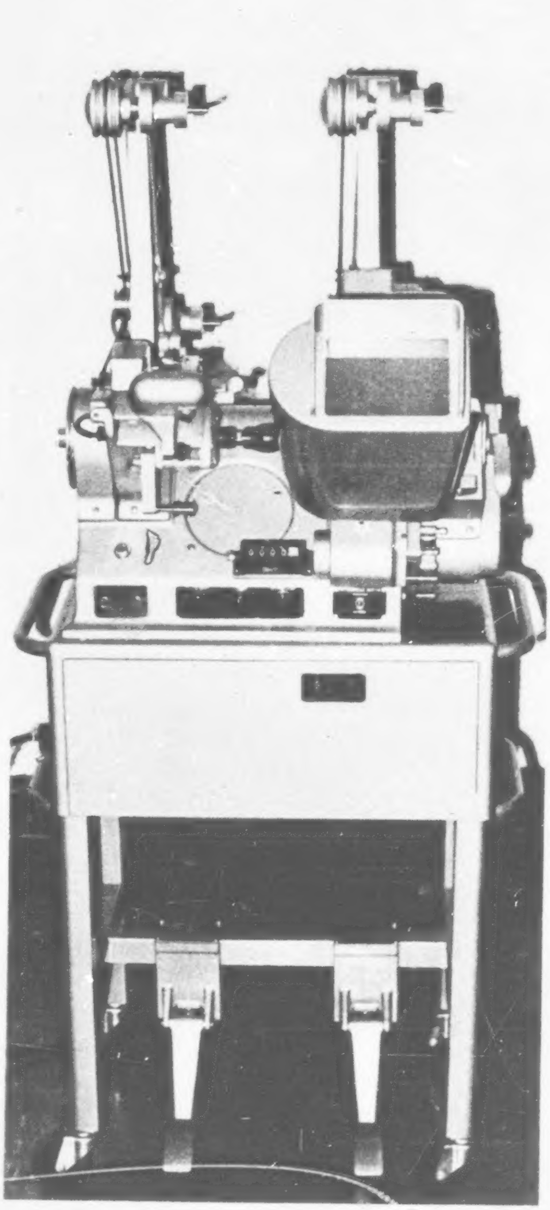
A refinement of this method is the electric slate. The electric slate produces a start mark at the head of each take on the film and tape simultaneously.

In the camera gate, the electric slate consists of a subminiature light bulb. When activated it fogs a frame or two of film. At the same instant that the light goes on to fog the film, a buzzer makes a signal on the tape. In some cameras like the Eclair NPR and the Arriflex BL this is accomplished automatically; in other cameras a button must be pressed by the operator after the camera and tape recorder are at speed and before the action starts.

The sound as originally recorded on the tape is not usable until it has been edited with the picture. In order for this editing operation to take place, the sound must be on sprocketed film so that the editor can run both the sound and picture together in synchronizing moviolas and double headed projectors. (See fig. 12-15.)

Editing devices, such as the Magnasync moviola, are used to aline the picture film and sound film in frame-for-frame synchronism.

In order to get the sound from the 1/4 inch tape onto magnetic film the sound must be transferred by hooking the output of the tape recorder to the input of a magnetic film recorder. However, if only this and nothing else were done, the magnetic film and the picture film would not be synchronized. The 60-Hz pulse recorded on the tape is a magnetic record of the speed of the camera motor during the filming of the picture. Therefore, if the pulse signal is used to control either the speed of the tape recorder or the film recorder during transfer, then synchronism can be maintained.



PH.554

Figure 12-15.—Magnasync moviola editor, 16mm.

Speed control is accomplished by a device commonly referred to as a resolver. There are two types of resolvers in current use; one controls the speed of the film recorder and the other controls the speed of the tape recorder.

In the resolver which controls the speed of the film recorder, first the output of the tape recorder is linked to the record input of the film recorder. Next, the 60-Hz pulse signal (either on a parallel or overlapping track) is fed into an amplifier.

The output from the tape recorder is around 1 or 2 volts. In the amplifier this pulse signal is amplified to 110 volts. The output of the amplifier is linked directly to the synchronous motor which drives the film recorder. As the tape in the recorder plays back, one channel dubs the sound track onto magnetic film while the other track drives the film recorder. Since the 60-Hz pulse is a sound record of the speed at which the camera was operating originally, during the filming of the picture, the film recorder operates at exactly the same speed as the camera. What is thus achieved is a second-hand version of using a synchronous motor driven camera and film recorder with none of the disadvantages. This method allows the use of any stereophonic tape recorder.

The other resolving system controls the speed of the tape recorder to conform with the original camera motor speed, rather than that of the film recorder. As the sound is transferred from the tape recorder to the film recorder, the 60-Hz signal is sent into the resolver.

The resolver sends an electronic pulse back to the tape recorder which varies its speed, thus compensating for variations in camera motor speed. This method requires the use of one of the variable-synch tape recorders on the market such as the Nagra.

Additional information regarding the techniques of double system sound may be found in chapter 13 of this rate training manual.

MAGNETIC SOUND RECORDERS

The sound track and photographic images are recorded originally on separate media in double system sound. The most common medium for the recording of sound at present is magnetic film or tape. This requires the use of a magnetic recorder, either film or tape. Since all magnetic recorders are basically the same in principle, only the Nagra tape recorder will be covered in this chapter.

Nagra Tape Recorders

The Nagra is a transistorized recorder utilizing 1/4-inch tape. It is either battery operated or can be operated off 110-volt a.c. by the use of a power converting unit. (See fig. 12-16, 12-17, and 12-18.)

The Nagra tape recorder can be shoulder carried and will operate about 15 hours on one set of 12 standard D type flashlight batteries and nearly 20 hours on industrial type batteries. Rechargeable batteries can also be used.

There are three available tape speeds: 15 inches per second (ips); 7 1/2 ips and 3 3/4 ips. The machine will record from 30 Hz to 16,000 Hz, and speed regulation is by servo-loop control.

The Nagra uses electronically controlled speed stabilization that will not deteriorate with time as does the mechanical system found in many conventional tape recorders. Any variation in the speed of a recorder will produce flutter.

The speed selector dial, located on top of the recorder (fig. 12-17), sets the operating speed and at the same time sets the equalization (tone control).

An operating speed of 15 ips, which is the internationally accepted standard, provides the best frequency response, 30 Hz to 16,000 Hz.

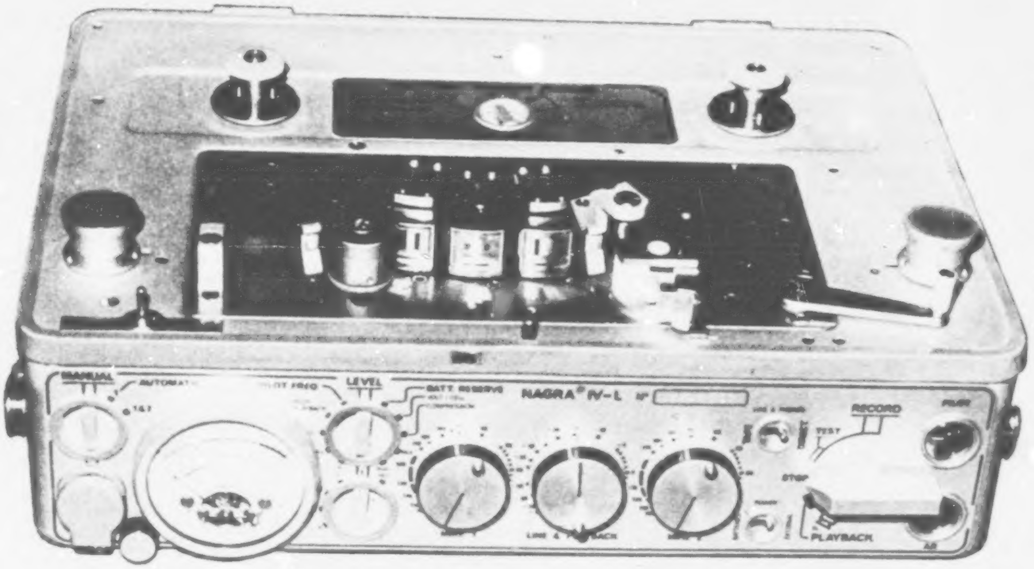
An operating speed of 7.5 ips is the speed normally used because it conserves tape while also providing good quality sound reproduction.

An operating speed of 3.75 ips cannot be used for sound transfer. It is used only when tape economy is important and high quality is not required. An operating speed of 3.75 ips does not meet the standards required for motion picture sound productions.

The microphone input (fig. 12-18) accepts a microphone with a three prong female cannon plug. The impedance range of the microphone should be between 50 and 200 ohms.

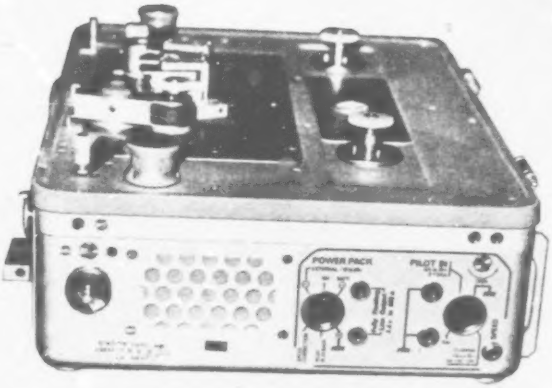
The line input (fig. 12-18) has an impedance of 100,000 ohms and can be connected to high impedance sources such as radio receivers.

A power converting unit can be plugged into the accessory socket. This unit converts 110 VAC line voltage to the recorder's proper operating voltage, and with an additional cord furnishes a 60-Hz pilot signal. With the aid of a preamplifier, an additional microphone can be


MANUAL
AUTOMATIC
PILOT FREQ
LEVEL
NAGRA IV-L
RECORD
TEST
STOP
PLAYBACK
LINE & PLAYBACK

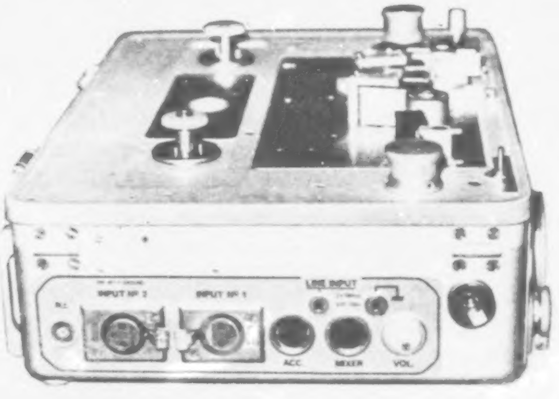
PH.555

Figure 12-16.—Nagra IV-L magnetic tape recorder (front view).


POWER PACK
PILOT IN

PH.556

Figure 12-17.—Nagra IV-L magnetic tape recorder (right side).


INPUT No 2
INPUT No 1
LINE INPUT
ACC
MIXER
VOL

PH.557

Figure 12-18.—Nagra IV-L magnetic tape recorder (left side).

connected to the accessory socket. The microphone is connected to the preamplifier, which in turn is connected to the accessory socket and to a 110-volt a-c outlet. The impedance of the preamplifier and microphone must match, (50 to 200 ohms).

The mixer, also an input socket, is used separate from the microphone circuit. It is used to combine or mix additional sources of sound such as audio busses, second microphone preamps, or multiple dial mixers.

The lag meter (fig. 12-16) measures the level of the sound being recorded or played back, on the top scale of the dial. The average sound level should be between -6 and -4 dbs with peaks to 0 db. If the needle reads in the black area, overmodulation is occurring, which causes distortion.

To prevent damage to the lag meter, such as burning out the windings or bending the needle, the level controls should be closed when setting the volume levels.

The power select switch (fig. 12-16) has two positions: batteries when battery power is used, and external when an outside power source is used.

Located to the right of the power select switch is the function selector switch with the following five positions (fig. 12-16):

1. The stop position.
2. Testing position. This position is used to determine the correct audio volume level prior to recording. In the test position sound can be heard on the monitor but not recorded.
3. Record position. In this position sound is being recorded. The modulation of the audio signal being recorded is indicated on the lag meter.
4. Playback (external). Sound is played through the 600 ohm balance output to external speakers. The modulations of the signal are indicated on the upper scale of the lag meter.
5. Playback (SL). When the selector switch is in this position, sound is played back through the recorder's built in speakers. In this position the condition of the batteries is also indicated by the bottom scale of the lag meter.

Located to the left of the lag meter is another selector switch with positions as follows:

1. In the manual position, the operator controls the record level of the audio signal.
2. When the selector switch is in the automatic position the tape recorder circuitry will automatically lower the record position on loud sounds and raise it on low sounds.

The automatic position should be used only when manual control is not possible. This is because the noise level of the background is raised to an objectionable degree. In addition both high and low frequencies will be cut out.

MAINTENANCE OF NAGRA RECORDERS. Due to the complexity of the Nagra recorders only the following maintenance should be performed:

1. Before commencing the day's recording session, degauss the recording and playback heads.
2. Check all external switches and connections for proper operation and any wear and/or looseness.
3. Clean the recording and playback heads with a Q-tip and ethyl alcohol.

No lubrication is required; all lubrication is accomplished annually by the manufacturer.

MOTION PICTURE LIGHTING

From the early days of photography, man has used the sun as his main source of light. As time progressed, the need for additional forms of light became necessary. These requirements brought about the development of special lights that were designed to improve both the scope and the quality of his work.

Present day motion picture lighting equipment includes almost a limitless number of lights designed for all types of lighting requirements. These lights vary from tiny bulbs designed for medical photography to the huge arc lights which nearly equal daylight in their intensity. The motion picture photographer must know his lights and how to use them as they are one of his most important tools in presenting his subject in a natural and pleasing manner.

Lighting equipment can be divided into two broad groups. These are FLOODLIGHTS and SPOTLIGHTS.

FLOODLIGHTS

Floodlights are designed to provide a uniform overall minimum exposure level of illumination. They are used to lighten shadows, illuminate backgrounds, and to give a soft general front light in closeups of people. Depending upon their design, they cover angles from 60 to 90 degrees. They are an incandescent bulb, inside frosted and have a screw base. They are designed to burn at approximately 3400 K for proper color balance. The various sizes of photoflood lamps are listed below:

Size	Wattage	Usable life	Type of base
No. 1	250	3 hours	Medium screw
No. 2	500	6 hours	Medium screw
No. 4	1,000	10 hours	Mogul screw
Movie flood.	2,000	Indefinite	Mogul screw

The SINGLE AND DOUBLE Broads are reflectors with a small flat frame which house one or two photoflood bulbs. These lights are frequently used without a reflector. They are designed to provide a soft, shadowless light, and are recommended for raising the general illumination level without causing shadows. They are mounted on portable extension stands.

The CINELIGHT has a parabolic type reflector which provides a more concentrated light. This light has a reflector 17 inches in diameter and generally uses a 1,000 watt photoflood bulb. The Cinelight is designed particularly for color lighting, and is mounted on a portable extension stand.

PORTABLE MOVIE FLOODS are smaller lights with 12-inch to 18-inch reflectors which use either a No. 2 or No. 4 photoflood bulb. They are mounted on lightweight collapsible stands for maximum portability and are generally used for assignments where the handling of equipment requires compactness and carrying ease.

SPOTLIGHTS

Spotlights are generally designed to provide a concentrated beam of variable spreads from 8 to 45 degrees. They are generally mounted in high efficiency reflectors with a FRESNEL LENS SYSTEM that insures more even distribution of light. A Fresnel lens is a plane convex condenser lens with segments removed for greater reflection and light refraction.

Most spotlights contain a prefocused projection type bulb designed for high intensity concentrated illumination. These bulbs come in many sizes and vary from 250 to 2,000 watts. Other special types are available up to 50,000 watts.

All spotlight bulbs have a prefix designator which indicates their use. These designators are MP, which are used for black-and-white motion pictures; CP-3350-K, which are used for tungsten Kodachrome; and 3200K, for commercial type Kodachrome.

Spotlights are generally considered the most useful of motion picture lights due to their characteristic of portability, varied spread of beam, and the accessories which may be used with them. There are numerous sizes and types of spotlights, the most common of which is described here.

The SENIOR SOLARSPOT Types 214 and 414 have a 14-inch Fresnel lens and a high-power spotlamp. They use a 5,000-watt lamp, which is a bipost prefocused bulb. The lamp will give a spread of 10 to 44 degrees, and is mounted on a heavy duty portable extension stand. This spot is recommended for use as a main or KEY light as it produces a strong, heavy shadow and reaches deep into the set. It comes with barn doors (for controlling the direction and spill of light) and diffusion screens for softening the light.

The JUNIOR SOLARSPOT is of the same type as the Senior Solarspot, except that it has a 9 7/8-inch lens, and uses a medium power lamp of 1,000 to 2,000 watts. This lamp is of the bipost prefocused construction also.

The BABY JUNIOR SOLARSPOT has a 6-inch lens, and uses lamps of 500 and 750 watts of the bipost prefocused type. It is light in weight and easily portable. All accessories listed under the Senior Solarspot are available for it.

The PHOTOSPOT is a self-contained 5-inch medium screw base bulb. The bulb has an inner surface silver-coated to form its own reflector. This reflector forms a fixed, concentrated beam and is designed as a small portable light. The color temperature of this lamp is 3400 K and the rated wattage is 500.

There is one other type of lamp that is used in the making of motion pictures. It is the high-intensity arc light. These are very bright lights varying from white to blue in color. They are designed for large sets requiring maximum light and are especially useful in color photography. They incorporate a special type carbon arc filament, mounted in a concentrated variable reflector. These lamps are classified according to amperage rather than wattage, and resemble the type of searchlights one usually sees at carnivals.

ACCESSORIES

There are various types of accessories that are used with the many types of movie lights.

Diffusing screens (SCRIMS) are transluscent screens of silk or mesh netting made up in various densities, depending upon the degree of diffusion desired. These scrims are placed over the light source and are recommended for softening effects, and especially for closeup scenes requiring a beautifying effect.

A SNOOT is a metal tube that reduces the beam coverage of the smaller spotlights through a movable mask and variably positioned lens. Some types contain a simple condenser lens to concentrate the small spot and to provide clean sharp shadows by adjusting the focal distance of the condenser lens.

Barn doors are movable metal doors that attach to the front of most spotlights to control the spread and spill of light into unwanted areas.

The accessories listed above are but a few of the many used in the motion picture industry.

SPECTRA PROFESSIONAL INCIDENT-LIGHT EXPOSURE METER

To set the camera aperture correctly, the cameraman must know the illumination intensity of the scene being photographed. This is usually done by means of a direct reading exposure meter, preferably of the incident type such as the Spectra. The theory and use of exposure meters, along with an illustration of the Spectra meter, can be found in chapter 7 of the Rate Training Manual PH 3 & 2, NavPers 10355-A. Information regarding exposure factors and the determining of exposure can be found in chapter 19 of the same manual.

SAFETY PRECAUTIONS

It is imperative that all personnel be indoctrinated in safety precautions necessary for safe handling of electricity. They should also be thoroughly familiar with the proper resuscitation practices used in electrical shock accidents.

ELECTRICAL CIRCUITS require certain safety features. Of these, the fuse is the most important. A fuse is a device to protect the circuit from short circuits and overloading. There are three common types: screw type, cartridge type, and breaker switch (circuit breakers). Fuses and circuit breakers are rated in amperes and are the weakest point in a circuit, intentionally made this way to protect equipment from an overload or short circuit. When an overload or short circuit occurs and more current than that for which the fuse is rated reaches the fuse, the fuse burns out. In the case of a circuit breaker, the breaker trips, breaking contact and stopping current flow at that point.

CAUTION: Never use makeshift heater strips, pennies, or over-sized fuses to replace blown fuses. This is a dangerous practice that can have disastrous results. FIND THE CAUSE FOR THE BLOWN FUSE, correct the discrepancy, then replace the blown fuse with one of proper amperage.

The use of proper size cables with adequate fusing in the circuit will reduce, if not eliminate, the danger of short circuits and overloading.

All lamps and extension cords should be inspected frequently to insure that they are in good condition. It is desirable to have an individual switch connected through each cord so the power can be disconnected with the switch instead of pulling out the connector plug. If several small lamps are to be used instead of one large lamp, a suitable junction box can be fitted to one heavy extension cord and the smaller lamps connected through the junction box.

The cords must be long enough to permit a reasonable amount of slack between the junction box and the lamp while in use. This slack should be more than enough for the average working distances, and should be able to reach some of the most distant setups without coupling together several extension cords. The fewer of these temporary couplings used, the less danger of trouble from faulty connections.

Fuses and Circuit Breakers

Electrical cords should be sufficiently heavy to carry the full load for which they are to be used. As a safety measure, an electrician should be called upon to check connections, cords, and the supply line for correct fusing.

Excessive loading of the electrical circuits creates fire hazards. To eliminate these hazards, it is necessary to work within the safety factor provided by circuit breakers. To determine the amperage required by a particular lighting unit, either of two systems can be used.

1. The exact system. Divide the rated bulb wattage by the circuit voltage; for example, a No. 4 photoflood is rated at 1,000 watts and the

circuit at 120 volts using 30 ampere circuit breakers.

1,000 ÷ 120 = 8.3 amperes

Hence, the 30-ampere circuit breaker can carry three No. 4 photofloods since 8.3 amperes x 3 photofloods equals 24.9 amperes. This allows a safety margin.

2. A rule of thumb. Point off 2 decimal places in the listed wattage of the light source to determine the amperage when using a 120-volt circuit and divide by 2 for a 220-volt circuit. For example, a 2,000 watt bulb equals 20.00 for the 110-volt circuit, or 20.00 ÷ 2 = 10 amperes when used on a 220-volt circuit. Therefore, a 120-volt circuit can safely accommodate one 2,000-watt light while the 220-volt circuit can carry two 2,000-watt lights.

The amperage rating of the circuit breaker for each circuit determines the safe working load. Adding the combined amperage of the lighting units indicates whether or not the amperage required by the lights is within the safety factor provided by the circuit breaker or fuse.

EQUIPMENT not kept in good repair can be a hazard. To reduce the possibility of injury, fire, or equipment failure, there should be a strict systematic program of preventive maintenance on all equipment. Proper setting up of equipment and stringing of cables, along with keeping the set clean, can also reduce hazards.

ALWAYS—Run cables along walls when possible; remove obstacles from the set; have all lights locked in position; check cable insulation for fraying.

NEVER—Drape cables; coil cables that are in use; place flammables (backdrops, props) where heat from the lights will ignite them.

PERSONNEL working on and around motion picture sets must keep their minds on their work at all times. A great quantity of electricity is used on a set and ELECTRICITY CAN KILL! Treat all electrical equipment with respect; even LOW VOLTAGE can KILL under certain circumstances, so BEWARE.

CHAPTER 13

MOTION PICTURE TECHNIQUES

Motion pictures, through the use of special techniques and effects, can develop a theme rapidly, create attitudes, convey ideas, and illustrate or demonstrate job skills. It is the purpose of this chapter to describe in some detail the methods and techniques that must be applied to achieve these goals.

GENERAL INFORMATION

Chapter 8 of the U.S. Navy Manual of Naval Photography, OpNav Instruction 3150.6 (Series), includes the following:

A general outline of motion picture utilization in the Naval Establishment along with pertinent definitions and detailed rules, policies, and procedures established by the Chief of Naval Operations; and the responsibilities for the development, production, distribution, and inventory of motion pictures delegated to subordinate commands.

Motion picture productions are effective in imparting information and for assisting instructional processes in learning situations. The two broad categories of motion picture productions are general motion picture and motion picture project.

GENERAL MOTION PICTURE PRODUCTION

To meet the requirements for a general motion picture, one or more of the following criteria is sufficient:

1. It will be a complex production requiring elaborate art work or titles, animation, music, sound and optical effects,. professional actors, on-screen narration, etc.
2. The motion picture will have general availability throughout the Navy.
3. Matters of policy involving current high-level interest, making it a desirable or necessary action to obtain formal approval by the appropriate authority, are included in the motion picture.
4. Professional production standards that have been established by the film and/or television industries are required by the motion picture.

Production Planning Essentials For General Motion Pictures

With the exception of certain productions for which the Chief of Naval Material has been designated as the claimant by the Chief of Naval Operations, funding for the project is provided by the claimant. The term "claimant" used throughout this chapter is defined as "A headquarters office which states requirements for general motion pictures, provides technical assistance in production, determines initial distribution, and normally funds the production. A claimant may also state requirements in any subject matter category with the concurrence of the appropriate production program sponsor."

The Chief of Naval Operations is the production program sponsor for the following claimants:

1. Deputy Chief of Naval Operations (Air Warfare).
2. Chief of Naval Training Support.
3. Chief of Naval Operations (Op-099).
4. Commander, Naval Communications Command.
5. Commander, Naval Intelligence Command.
6. Commander, Naval Surface Reserve.
7. Director, Civilian Manpower Management.
8. Commander, Military Sealift Command.

The Chief of Naval Material is the production program sponsor for the following claimants:

1. Systems Commands.
2. Chief of Naval Research.
3. Oceanographer of the Navy.
4. Commander, Naval Weather Service Command.
5. Chief of Naval Material.

The following are both production program sponsors and claimants:

1. Commandant of the Marine Corps.
2. Chief, Bureau of Medicine and Surgery.
3. Chief of Naval Personnel.
4. Chief of Information.
5. Chief of Chaplains.
6. Commander, Naval Recruiting Command.

The term Production Program Sponsor as used in this chapter indicates "A command, office, or bureau exercising control of a production program in a particular subject matter category under the general policy guidance of the Chief of Naval Operations." The production program sponsor implements established policy and procedures, determines total requirement priorities, and coordinates the program within the category.

The production supervision for general motion picture productions is normally provided by the Chief of Naval Material (CHNAVMAT). The criteria for the selection of a general motion picture production are based upon the following: available technical resources, claimant's priorities, judgments of cost effectiveness, and professional production standards.

Each claimant for a general motion picture production assigns a motion picture liaison representative to coordinate the claimant's requirements. He is the vehicle for expression of the claimant's views and policies.

The Chief of Naval Material, for photographic activities having the capability, will provide limited technical assistance in the planning, supervision, and production of motion picture projects.

All general motion picture requirements, and motion picture projects that carry a recommendation for public exhibition, will be forwarded to the Navy's Chief of Information of the Marine Corps Director of Information as appropriate for coordination with the Assistant Secretary of Defense (Public Affairs) prior to approval by the claimant or originator.

Requirement Statements

The following information is to be provided in the requirement statement drafted for each general motion picture:

1. Claimant.
2. Subject matter category.
3. Fiscal year in which required, and specific date if significant.
4. Title (working or tentative, if appropriate).
5. Identification number, if adopting an existing production.
6. Short synopsis of content.
7. Security classification and declassification group.
8. Brief justification for the requirement in terms of objectives and audiences. Cite commands, offices and bureaus other than the claimant which have verified a need for the motion picture. Indicate the relative ranking of importance of the requirement as compared to other requirements of the claimant.
9. Indicate revision of a motion picture in the inventory or addition to an existing series, if applicable, giving titles and identification numbers.
10. Probable location(s) for photography.
11. Recommendations for public exhibition if appropriate.
12. Estimated useful life of content.
13. Running time.
14. Number of prints for initial distribution.
15. Attach list of prospective end-users with print quantities for each.
16. Amount of production funds budgeted.
17. Point of contact for coordination (name, address, phone number).

The Commandant of the Marine Corps establishes the format for reporting Marine Corps motion picture requirements. Requirements for general motion pictures are submitted to the Chief of Naval Material (CHNAVMAT) for inclusion in the annual Navy motion picture program. The Chief of Naval Operations approves the total program following compilation of all requirements under the direction of CHNAVMAT.

MOTION PICTURE PROJECT

The production of a motion picture is designated a motion picture project if the following requirements are met:

1. The picture is for a particular limited need.
2. Policy approval by higher authority is not required.
3. The product will be of reproducible quality and feasible to produce without elaborate detail.
4. The product will be effective without reference to professional production standards.

Estimated length of the motion picture, funding, initial distribution, length, production supervision, and the technical advisor for a motion picture project are normally provided by the originator.

Registry of Motion Picture Projects

In order that a central source of information on these limited productions be available to all potential users, all completed motion picture projects will be registered with the Commanding Officer, Naval Photographic Center.

Motion picture sequences which are a part of multimedia training packages are exempt from the registry procedure stated above.

Usable information must be forwarded to the Naval Photographic Center in order that the motion picture project can be catalogued in the Naval Film Catalog. The originator, however, may identify and catalog, by any means desired, motion picture projects for inhouse purposes. Requests for prints or preprint materials of these projects will be submitted to the originator of the item.

Prints for supplementary distribution will be provided by the Commanding Officer, Naval Photographic Center, if the originator concurs and if funding and workload at the Naval Photographic Center permit.

AVAILABILITY OF MOTION PICTURES TO EXTERNAL AUDIENCES

Prior to public viewing, Navy and Marine Corps general motion pictures and motion picture projects not previously cleared for public exhibition will require clearance by the Navy's Chief of Information or the Marine Corps Director of Information, as appropriate.

Normally the requirement statement, script, and finished production will be reviewed as they are completed. Legal rights and instruments acquired for talent, music, and other copyrighted materials in the production will also be reviewed.

The individual services may make available, for public viewing, cleared motion pictures on a limited free loan basis. In addition the National Audio-Visual Center, National Archives and Records Service (GSA) Washington, D. C. 20409, provides for the rent or sale of cleared motion pictures.

ALTERATION OF INVENTORY PRINTS

With the exception of legitimate informational and instructional purposes, and then only with the concurrence of the claimant or originator, motion picture prints will not be cut, duplicated, or otherwise altered.

Prints approved for alteration will be modified to destroy their identification as inventory items (general motion pictures or motion picture projects). This identification will also be removed from the print container. The user will retain the altered motion picture prints.

Requests to alter proprietary motion pictures or those produced by other DOD components must be forwarded to the Chief of Naval Material for approval. The concurrence of the Navy's Chief of Information or the Marine Corps Director of Information as appropriate is also needed before the public showing of any altered print.

INVENTORY MANAGEMENT OF MOTION PICTURES

Cataloging, distribution, and inventory control of motion pictures in film and video-tape media, and coordinating with claimants, production program sponsors, and libraries will be provided by the Chief of Naval Material or the designated subordinate Systems Command.

Further details of policy and procedure regarding motion picture planning, production, distribution, and inventory control may be found in chapter 8 of the Manual of Naval Photography, OPNAVINST 3150.6 (Series) and in supplementary instructions as required.

FILM SLATING

The motion picture camera operator is concerned with two types of slates: the head slate, covered in full detail in chapter 19 of the Rate Training Manual, pH 3 & 2, Nav-Tra 10355-A; and the scene slate. The scene slate is used in motion picture photography as an aid when editing the film. The following information should be provided on each scene slate:

1. The film's title or project number at the top of the slate.
2. The scene number in large numerals.
3. The take number in large numerals.
4. The sound take number (if sound is being recorded) and an indication as to whether it is single or double system sound.

DATA SHEETS

After the "Photographer's Data Sheet" (NavAir Form 3150/5) has been completed (in accordance with instructions in the PH 3 & 2 Rate Training Manual) the original copy with a letter of transmittal is to be forwarded to the Naval Photographic Center (NPC). One copy of the data sheet is enclosed with the film, one copy retained for local files, one copy forwarded to the Chief of Naval Information (CHINFO) if the film is of national news value, and one additional copy to each other interested party or possible user of the film.

PACKING AND FORWARDING MOTION PICTURE FILMS

All classified film is to be packed and shipped in accordance with existing security regulations and instructions contained in the United States Navy Security Manual for Classified Information, OpNav Instruction 5510.1 (Series) and the Manual of Naval Photography, OpNav 3150.6 (Series). The film is to be separated by film type within the package to facilitate handling at the receiving end. Separating the film by types allows the processing crew to assemble the film by roll number sequences and reduces the possibility of an error in processing.

Data sheets, if attached to the film cans by tape, should be overwrapped, to prevent the tape from sticking to the surface of the data sheet. Data sheets and other enclosures such as news clippings of the event, PAO releases, programs, lists of events, lists of people present, and any other available information or background material must be plainly marked to prevent any confusion with the wrapping material.

The package is double wrapped with the security classification stamped on the inner wrap. After the film has been packaged and addressed it is sent by registered mail or Armed Forces Courier Service.

Forwarding of Motion Picture Film

All exposed motion picture film, unless there is an immediate local need for its use, must be forwarded unprocessed to the Naval Photographic Center. A letter of transmittal, data sheets, and other available information and background material must accompany the film. The following coverages, both motion pictures and still photography, are to be sent immediately and by the fastest means: Combat action, intelligence, disasters, both local and national, and film with a nationwide news value. All other coverages can be forwarded by regular mail, as soon as possible.

Intelligence photography not requiring processing by NPC is to be forwarded immediately and by the fastest means to the following address:

Defense Intelligence Agency
(DIAAP-1L)
Department of Defense
Washington, D.C. 20507

Film packages, within weight and size limitations, can be sent by regular mail or by airmail under a government "frank." Film packages in excess of the weight and size limitations of the postal department are shipped by the supply department.

Film to be shipped immediately by the fastest means may be shipped by air express and a bill of lading obtained from the supply department. When a film shipment is made by air express a message should be sent to NPC, stating the amount and type of film, its subject matter, the bill of lading number, airline(s) carrier and the estimated time of arrival at the airport in Washington, D.C.

Refer to chapter 19 of the PH 3 & 2 rate training manual for further information regarding data sheets and the forwarding of film.

Letter of Transmittal

All film sent to government agencies must be accompanied by a letter of transmittal, with the film listed as an enclosure to the letter. If the film and letter of transmittal are packed and mailed under separate covers, a copy of the letter should be enclosed with the film. Copies of the letter of transmittal should be mailed along with the data sheets to all interested parties; i.e., requesting agencies, CHINFO, etc.

The letter of transmittal has the same security classification as the film until the contents (film) are removed. The letter is to contain information regarding the amount and type of film shipped, whether or not the film has been processed, the subject matter of the film, and its classification.

THE UNIT

The answer to the truly successful motion picture lies in the combined talents of a group of artists and technicians who work as a team. This team is referred to as the CREW, and, assembled in its entirety, it is called the UNIT.

A naval motion picture unit is made up of a group of key members and their assistants, each person having to take on more responsibility than would ordinarily be expected of him were he in the motion picture business in civilian life.

The key members usually assigned to a Navy motion picture include a director, a cameraman, a chief electrician, a sound engineer, and a technical adviser. Others apt to be assigned as assistants to these men are an assistant cameraman, a soundman, electricians, grips, property man, stage hands, still man, and often a script supervisor.

Director

The director is a man of imagination, vision, and great responsibility. It is his task to translate the master script into a film story. He is expected to make the finished motion picture resemble the approved script as closely as the limitations of the medium will allow.

The quality of the finished picture reflects the director's ability. Its success will hinge on his accurate and skillful handling of the personnel and funds allotted to him.

The director's major responsibilities include the selection and final approval of the cast, the assembling of the film into balanced sequences, and the designation of the manner in which the actors project the feeling of the script into the minds of the audience. He is responsibile for the creation of a film story through an understanding of the script and through his knowledge of acting, camera work, and editorial cutting.

Cameraman

The first cameraman, generally a civilian or chief photographer (PHC), is in charge of the photographic coverage and camera work to be done on the film. He and his staff are responsible for the quality of the finished image as it appears on the screen. The screenplay is best told through mutual understanding and cooperation between the director and the cameraman; that is, the combining of these two skills as a means of telling a story.

Actually, the cameraman is more concerned with expert lighting of the set than the camera work, for he knows that it takes a combination of mechanics of camera operation coupled with good set lighting to capture the mood of the scene and the players. Though he has final say on the lighting setups to be used, he will always strive to blend his talents with those of the chief electrician in an effort to come up with the most desirable and technically correct lighting of a scene.

The cameraman must devote his constant study and attention to composition, selection of camera position, and key lighting. He strives for fluidity of movement to capture significant details and moods with photographic clarity and definition.

The first cameraman rarely acts as the camera operator. He devotes his time, as has been shown, to composition, lighting, and the smooth flow of action on film from one scene to another. He indicates where the camera is to be placed on the set so that it will best record the effects desired by the director. He will also designate the lens that is to be used.

The ASSISTANT CAMERAMAN is also known as the operating cameraman and is the assistant to the first cameraman. He physically operates the camera. The assistant cameraman is responsible for the readiness and availability of all camera equipment that will be used to cover the scheduled shooting. The equipment and accessories required for each setup are placed or located on the set under his direction. The technical aspect of making a movie also comes under his jurisdiction. In other words, the assistant cameraman is responsible for the camera operation and for the sharp focus of every shot as well as the overall efficient operation of the equipment during the filming of each scene. He starts and stops the camera as directed, physically changes lenses, and loads and changes the magazines.

The CAMERA REPORT is generally kept by the assistant cameraman. He must be sure that this report contains a record of each shot giving the number of feet of film exposed, the type of film used, the subject matter, the lens used, and the exposure given each shot.

Chief Electrician

The chief electrician, or "gaffer" as he is called in the trade, is in complete charge of all electrical equipment and electrical hookups required for the filming of the picture. He is responsible for the availability of all electrical gear, lights, cables, stands, flags, etc. He must also supply the electrical current necessary to operate this equipment either by connecting into the main lines in a building or by using portable generators.

On the set, the chief electrician will rough in the lighting with a basic lamp setup as instructed by the cameraman. He will then place the lights in such a manner that the full lighting effect described to him by the director and the cameraman is achieved.

Sound Engineer

The sound engineer is responsible for the quality of the recorded sound and for the reliability of the sound equipment during production. It is his duty to create an aural illusion that will fit the visual presentation.

If a production is scheduled to be a sound motion picture, it will have a sound unit which consists of a sound recorder, mixing console, microphone, microphone stands, and all necessary cables. This unit will furnish the power and is responsible for insuring that the recorders and cameras operate in synchronization to produce quality sound.

The sound crew consists of the following:

1. A Head Sound Man (sound engineer), who operates the mixing console to control the level and tone of the sound being recorded. He is assisted by
2. The Boom Operator, who is responsible for the proper microphone placement as well as the manipulation of the microphone when attached to a boom during a sound take.
3. A Recordist, to operate the recorder and the mixer.

Still Man

The still man is an extremely valuable individual during picture production and his role as a crewmember should be included in a discussion of motion picture production. It is not mandatory that a still man be assigned to a picture. However, the service he performs during the filming, especially in a picture which involves many sets or many wardrobe changes, can be invaluable.

While the picture is in the shooting stage, the still man is called in at the end of each scene to photograph the position of inanimate objects, general layout of the set, and posture and position of the actors as they finish the scene. These pictures, called set stills, are indispensible during out-of-continuity filming.

The script supervisor has physical custody of the 8 x 10 inch glossy prints. Each is logged with pertinent information such as scene number, day the scene was shot, time of day, location, set number, cast, script page, and camera setup information (such as lens used, lighting, and exposure). These set stills are filed at the end of shooting and can be pulled later by the film editor if there is some question of scene matching.

The still man in the Navy can usually be acquired from the local photo lab whenever the production crew is filming. However, when the picture is on location, a still man is added to the official crew.

Technical Advisers

A technical adviser can be defined as a highly qualified individual who is assigned to a motion picture production to serve as an official overseer, representing (in the case of the Navy) the requesting activity or original requesting authority, from the time that the production of the film is submitted for consideration until its completion.

The duties of the technical adviser are rather broadly stated and the degree of participation in the actual filming will be proportionate to the scope of the production. In military productions it is general practice (where the film is to be of a highly technical nature) to have a technical adviser as an active member of the production staff. His duties are discussed in the following paragraphs.

The technical adviser reviews and approves the production outline for completeness and accuracy. He accompanies the writer and project supervisor to locations where equipment or operations involved in the film may be viewed and explained in detail to the writer. He is responsible for supplying technical information, publications, and documents as required.

Once the action outline and master script are completed, the technical adviser reviews and approves them from the standpoint of content, technical accuracy and completeness. He also reviews and approves the scene directions, artwork instructions, and narration, insofar as they affect the technical accuracy of the film.

During the filming stage, the technical adviser provides personnel, properties, and equipment. These ordinarily come under the cognizance of the requester or local command. He supervises and guarantees the authenticity of sets required for filming and he must be available on the set at all times during the photographing period. He also determines the classification of all scenes photographed. It is his responsibility to insure that the action being photographed is accurate and correct. His approval must cover the authenticity of speech, action, costumes, sets, technical equipment, etc. The artwork is also checked and approved by the technical adviser. He attends screenings of the daily workprints (rushes) for the purpose of reviewing and approving them.

During the editorial phase of the production, he must be available to assist the film editor by checking the rough cut, and the narration must be read with it for both content and organization.

When the interlock approval screening is about to take place, the technical adviser is required to make certain the changes recommended at the rough screening have been made and the editing has not destroyed technical accuracy. At the same time he approves the sound track recording with respect to pronunciation of technical terms, the authenticity of sound effects, etc.

The technical adviser's duties come to an end in the production phase at the time he is called upon to view the final composite print. This is the final approval and acceptance stage. At this point he assures himself that all changes and corrections made at the interlock screening have been incorporated. His last official duty with the unit is to approve the complete picture from the viewpoint of technical accuracy and completeness.

Grips

The grip is most often referred to as the picture company handyman, or "jack-of-all-trades," who takes over from union construction personnel, such as carpenters, electricians, and painters, the moment the camera rolls the first frame in front of the lens. His behind-the-scenes responsibilities range from the care and preservation of all miscellaneous equipment used in the picture, to the hanging of the open overhead scaffolding. The grips actually operate the sets, or as it is called in the industry, "dress the sets," while filming is under way, and most often they take their orders directly from the cameraman. Among their duties are the laying of the camera tracks before each scene and managing the propulsion of the camera if the dollies are manually operated.

Most grips will have a degree of experience in carpentry, plumbing, painting, and machine shop work and may be called upon to solve problems which might arise in any one of these areas during production. In the Navy, the grips take on added responsibilities such as those of the property man who procures and keeps available portable items which appear in each scene of the picture.

The foreman of the grips is often given the title of "head stage hand." However, in military films the assistant director, script supervisor, or an assistant to the cameraman could serve as head grip.

Script Supervisor

Occasionally a script will be so complicated that the director and his immediate assistants cannot keep track of all the details. In this case, a script supervisor will be assigned to the production. It is the task of this individual to observe and record everything that happens on the set or sets. A record of everything that happens on every "take" must be catalogued.

He particularly watches for these pitfalls when action is shot out of continuity. Some cameramen utilize the services of the script supervisor by assigning him the duties of camera historian. He keeps a record of the lens used for each take, diagrams the area where the sidelines fall on the set in each take, and keeps an accurate record of footage that has been exposed. In other words, he diagrams the physical movement, camera handling, and minute-by-minute progress in each scene of the picture.

NAVY MOTION PICTURE COMBAT CAMERA CREWS

Navy motion picture combat camera crews are normally made up of four men; these men are the crew chief, first cameraman, second cameraman, and a grip. Each man on the crew has many responsibilities as indicated in the following description:

1. The crew chief is typically a chief or first class petty officer and a graduate of a 1-year cinematography course at the University of Sourthern California in Los Angeles. The crew chief is responsible for the quality of the film produced by the crew and serves as the unit's director, coordinator, and liaison between the requestor and the group's headquarters. The crew chief has full authority over the camera crew and is responsible for their training, travel arrangements, berthing, and other matters pertaining to the welfare of the camera crew.
2. The first cameraman is responsible to the crew chief for the readiness and availability of all equipment connected with the production. He operates the main camera under the direction of the crew chief and assists him in production planning. The first cameraman in addition insures that all film has been properly slated and that accurate data sheets are kept.
3. The second cameraman acts as an assistant to the first cameraman, operates a "cut" camera when directed by the crew chief and acts as the data recorder and script supervisor.
4. The grip assists the team with the recording of on-the-scene sound and the setting up of auxiliary lights and operates a "cut" camera when directed by the crew chief. The grip must be able to fit himself to any job that needs doing and by his own initiative handle all loose ends of the production.

THE SCRIPT

The script, often described as the filmmaker's blueprint, is the working plan employed by technicians to translate an original idea, a novel, a magazine story, a news event, or simply, fictional fantasy, into a motion picture. More specifically, the script is a detailed guide of the action that will take place, the dialog that will be spoken, and the camera angles that will be required for any movie production whether it be a 1-minute television short or 120-minute drama. The script of every commercial film is perfected to the finest detail before the cameras begin to roll. Economy is the keynote in picture production. Most professionals agree that the well-planned script will usually mean a better integrated film—one produced with a maximum of skill at a minimum of time and expense.

SCRIPT WRITING

Script writing is a highly specialized occupation, and those who have chosen to follow the profession appear to possess a special ability to think pictorially. That is, they are capable of visualizing characters, scenes, and actions as one pictorial unit. The script writer presents his type narrative as though he were viewing life through the lens of a camera. Scriptwriting cannot be compared with other methods of literary storytelling, for it is unique in that its appeal is directed to TWO of the sensory organs at one time—the eyes and the ears.

The development of a good script follows a planned pattern which begins with the original idea for a scenario and ends with an actual diagram for production.

Script Types

Three types of scripts that are of concern to the motion picture cameraman are the sequential, montage, and the animation type.

1. The sequential script is frequently used in training films. In this type script the action is directed from the completion of one objective to the next in a sequential manner.
2. Montage type scripts are generally used in public affairs type films to put across ideas rather than details. The montage script uses separate individual scenes that may or may not have any relationship to one another. The idea behind this script is to put the individual scenes together in such a manner that a concept is imprinted on the viewer's mind. The Victory at Sea and Fighting Lady programs are examples of a montage type script.
3. Animation type scripts also found in training films are excellent for explaining detailed points. This type script, is used for the production of a motion picture composed entirely or mainly of animated drawings and/or objects.

ELEMENTS OF THE SHOOTING SCRIPT

The shooting script, sometimes referred to as a SCENARIO, SCREENPLAY, or CONTINUITY SCRIPT, is the elaborated breakdown of the treatment (action outline) into actual scenes and sequences, with action and dialog clearly defined.

Each technician, as well as the artists, receives a copy of the script. The script includes such information as scene locales, costumes, camera setups, required lighting, props needed, and the photographic special effects necessary to complete the day's shooting.

Shot Breakdown

To write a script for shooting, certain rules of production must be followed. There has to be a plan to insure that scenes and sequences will tell the full story with logic. SHOT BREAKDOWN is used to realize maximum economy in film production. It breaks down shots to achieve a minimum number of camera setups and maximum utilization of actors and extras for the shortest possible time by cross-referencing scenes in which they are used.

The standard basic technique for shooting sequences and scenes has been covered in chapter 19 of Photographer's Mate 3 & 2 NavPers 10355-A. However, the role of the writer in reference to photographic coverage of segments of the story has not been mentioned previously.

It is the writer's responsibility in planning separate scenes of the script to consider "point of view"; i.e., camera angles and image sizes necessary to tell the story most effectively. He must always keep in mind that point of view is controlled by the subject matter of the scene. In other words, the importance of that which is to be featured will be the deciding factor in the matter of how the subject will be shown photographically. Essentially, each scene will have several points of view. Therefore, a quick review of the various kinds of shots used for presenting these points of view, as well as the order in which they are used, might be helpful at this time. The most commonly exercised technique for shooting a sequence of scenes is as follows:

1. The long shot (LS) establishes or locates a scene. Generally the long shot will find the camera situated at quite a long distance from the subject, giving a somewhat panoramic view of terrain, people, or areas.
2. The medium shot (MS) is not as emphatic as the closeup, however, it serves somewhat the same purpose. It shows the same view as the LS, but from a middle distance and a slightly different angle. It is used as a transition or bridge shot, which reestablishes the scene.

3. The closeup (CU) brings the audience right into the subject. It is invariably used to emphasize points, action, or moods. This shot will generally show the subject from the top of his shoulders to a few inches above his head.

4. The extreme closeup (ECU) will show much the same view as the CU. However, it may be used to add drama or further emphasis to the subject matter. The extreme closeup is a very large view of an object which fills the entire screen. For example, the face may be cut by the frame at the chin and the top of the head, or may even show just a portion of the face such as the eyes or mouth.

The presentation of the story and events in a logical technical sequence is also a requisite of the proficient script writer. Thus, one can see why it is so important for the writer to be thoroughly familiar with the photographic aspect of motion picture production.

There are exceptions to the 1-2-3-4 order for shooting scenes, but to maintain continuity and coherence, the common practice is to tell the story through the camera lens by following this basic method. An interesting example of reversing the 1-2-3-4 order is a suspense picture which opens with an extreme closeup of a murder weapon. The camera then pulls away to a closeup shot of the weapon and the victim, thence to a middle shot showing the weapon, victim and part of the room, and ending the sequence with a full view showing the entire death scene. In reality, the eyes first see the death scene as a long shot and then progress to the extreme closeup in a 1-2-3-4 order. For dramatic effect in the film, the writer and director changed the point of view in this example of an exception to the normal order. The scene sequence is now 4-3-2-1.

Continuity

The interrelating of scenes into a unified coherent pattern is known as continuity. Scenes are written so that the action may be photographed in sequences which will be continuous and will allow the viewer to follow an uninterrupted and continuous line of thought from beginning to end. If the screen story "hangs together" and leaves no gap in the action or doubts in the minds of the audience, it has smooth continuity.

Matching Action

Probably the most important factor in continuity is "matching action." When matching action, from scene to scene, it is not only vital to keep in mind screen direction; you must also remember the positions of the moving parts of the subject and of the animate and inanimate objects which surround it. No matter how much confusion or time lapse there is in a scene, if the scenes are to tell a story with smooth continuity and relationship to one another, the image placement of the animate and inanimate objects must be identical at the point where the scenes are joined together. Thus, good matching action and correct image placement will help create smooth continuity.

Sequences

A sequence may be defined as a group or set of photographic shots which serve to tell some portion or phase of the action in the story. One of the first steps in composing the shooting script is to break down the action into a series of sequences. Each sequence can be divided into individual scenes or shots. Each scene or shot is a unit within itself; but as pointed out earlier, its pattern and meaning are dependent upon the scenes or groups of scenes that precede or follow it.

Buildup and Tempo

Buildup is the technique used to present scenes relating to the main subject of the story in such a manner that interest, atmosphere and continuity are instilled in the minds of the audience early in the picture.

The ideal script is arranged so that it has a gradual buildup, with each sequence building to its own subclimax before going to the next part of the story. Each sequence builds higher than the last. An overall rise in audience interest takes place and the picture ends with a climactic sequence which is often the greatest point of action or interest in the film.

In practice, a script cannot continue in a perfectly straight line. A diagram of an ideal script might look somewhat like a mountain range, with each subclimax reaching higher than the last. Between each of the peaks there is a lull or temporary letdown to give the audience a chance to "catch its breath," and to reorient.

A film story should begin in an active key, one that is lively, dramatic, and interesting. Leisurely openings tend to lose audience attention. Without a change in pace or tempo in the script, boredom, confusion, or tension will usually set in.

Other photographic special effect shots employed to enhance or define the story are discussed in the following paragraphs. Each script writer must know how to skillfully use these shots during the preparation of the shooting script.

INSERTS are related shots which transpire at the same time as the current action. They are used between or during scenes to shorten or lengthen time, and also add interest to the story. Such scenes are invaluable during the editing of the film, for they serve to connect shots in which there is a gap in continuity, or when it is necessary to change the camera angle. Two of the most commonly used inserts are the cutaway and the cut-in shots. The cutaways (reaction shots) are views of crowds or individuals, showing their response to whatever is taking place. Cut-ins are generally made to interrupt the main action long enough to give an extreme closeup of the action.

The PARALLEL ACTION shot is another photographic device used as a related shot. The parallel action shot indicates several actions taking place at the same time and is accomplished by repeated cutting back and forth from one situation to the other. It heightens suspense and aids in creating audience interest.

A special impressionistic effect used quite often in motion pictures is the MONTAGE. This type of shot is a series of quick overlapping flash views used to fill in where segments of a story would stretch out into long footage. Called "shorthand of motion pictures," the montage is a useful tool. In a matter of seconds it allows the coverage of extensive time lapses in the story. It can show progress in a journey, an individual's rise to fame, or an entire battle segment. It can arouse an emotion, create a mood, establish an atmosphere, or intensify the excitement of an event or spectacular occurrence.

Another element of script writing which is most important and should be handled carefully by the writer is the use of transitions.

A TRANSITION may be defined as a bridge that permits a smooth passage of time while the film changes from one sequence to another. When a close relationship exists between sequences, a symbolic single shot may be used as a link between the two. Transition links may be constructed by using such optical effects as fades, wipes, or dissolves. Optical effects for motion picture photography are discussed in chapter 19 of Photographer's Mate 3 & 2, NavPers 10355-A but are defined here as they apply to the writing of a screenplay.

The FADEOUT is used at the end of a sequence to insure a definite and full stop to a train of thought. Its use can be compared to the curtain between acts or at the end of a play. FADE-INS are used to begin a picture or follow a fadeout and should be used only at the start of an absolutely new idea, action, or setting, used together they can show a lapse in time. They can be compared to a curtain at the beginning of an act of a play.

DISSOLVES are used to connect sequences where a smooth lapse of time or change of location is desired, so as to retain good continuity and close relationship of the two sequences.

WIPES serve the same purpose as dissolves. The choice of a wipe or a dissolve will depend upon composition, mood, screen direction, or tempo of the story. At all times, transitions must appear to be logical and inevitable to the audience.

NOTE: These effects are no longer done in the camera.

Action Outline

The action outline is a complete breakdown of the production outline, and it segregates the story into scenes and sequences. This outline contains voluminous notes on narration and dialog, or both. If necessary, notes on special effects and photographic techniques desired to help portray the drama of the play are incorporated.

An action outline serves to tell the story vividly and in detail. It describes settings and locales; it defines characters and tells who they are, what they want, what is blocking their way, and how they go about achieving their goal. It is written simply and presents the essence and theme of the story clearly and interestingly. The outline is written in terms of visual picturization of the story.

A sample portion of an ACTION OUTLINE is shown here to familiarize the Navy photographer with the mechanics of such an outline. Only a small portion of the outline can be shown in this chapter, but it should suffice to clarify its content and use.

ACTION OUTLINE
(With notes for narration)

THE COPPERSMITH

FLARING AND REDUCING
COPPER PIPING

Shipbuilding Skills Series

1. MLS - FLARED COPPER EXHAUST PIPE (IF POSSIBLE, ON BOARD SHIP WITH STEAM OR SMOKE COMING OUT).

   NARRATION: Properties of copper which make it practical for use aboard ship: metal malleable, stands vibration, expansion and contraction, weather.

   DISSOLVE TO

2. CU - FLARED CUP JOINT.

   NARRATION: Practical uses for flared pipe: exhaust pipes, cup joints, intake pipes. Explain why flare necessary.

   DISSOLVE TO

3. CU - COUPLING JOINT, SHOWING PLACE FOR FLARED END OF SMALL COPPER TUBING. WORKER FITS A LENGTH OF FLARED TUBING INTO THE JOINT.

   NARRATION: The simplest form of flaring is that done on small copper tubing, for fitting to coupling joints.

   CUT TO

12. CU - FLARED TUBING BEING JOINED TO ANOTHER LENGTH OF TUBING WITH COUPLING JOINT.

   NARRATION: Small tubing such as this is used for fuel and air lines

   FADE OUT

   CUT IN

13. MCU - ANOTHER WORKER PLACES PIPE (FINISHED) ON RACK. CAMERA HOLDS ON PIPE, EMPHASIZING FLARE, AS WORKER GOES OUT.

   NARRATION: Explains flaring, (i.e.) stretching the metal at the end of the pipe to a larger diameter. This is a hand operation.

   CUT TO

15. MCU - HOLDING PIPE IN TONGS (OR CLAMPED IN VISE), THE WORKER ANNEALS IT ON ONE END.

   NARRATION: For this reason the pipe must be annealed to soften the metal before it can be flared.

   PAN WITH WORKER TO

The foregoing has been extracted from an actual ACTION OUTLINE of an official Navy training film. It skips some scenes as can be noted by the scene numbers on the left.

THE PRODUCTION

RESEARCH

The impression of absolute reality must be reflected when a picture goes to film. The time and place to be re-created must always be factual and correct in every respect. Research prior to production is the best insurance that this accuracy will prevail.

Modern-day audiences, whether military or civilian, are quick to recognize the smallest error. To the producer, small inaccuracies may not be significant, but to the audience they are a source of disillusionment. This leads to a loss of viewer interest in the basic plot. Ignoring the need for accuracy and falling back on "dramatic license" does not allow for the fulfillment of the mission of motion picture production. Authenticity throughout is the key to the success of any motion picture.

PRODUCTION PLANNING

When the master script has been finished, it is good practice to pretest it before it goes before the cameras. Accuracy of terminology and all written procedures should be checked and verified with experts on the subject. A review by capable technicians is the best insurance against a poor film and it should be done with the utmost care.

Frequently, much time is expended turning out a good script only to nullify the effect in actual shooting by ignoring one important step in the preparation—production planning.

The "ironing out" of all preshooting problems should be taken care of during the preplanning stage. Once shooting schedules have been established, they should be adhered to throughout the entire filming period. Sticking to a rigid shooting schedule results in a smooth running and economically sound production.

A preliminary conference held with the various technicians and departments concerned with the production of the film should involve the following:

1. All personnel involved with the production should become familiar with the story idea and technical requirements of the script.
2. Basic standards of operation set up.
3. Anticipate and prepare for any problems that might occur during the shooting of the film. Problems that might occur are finding suitable shooting dates and/or locations and coordinating the work of different departments. When scheduling the shooting dates and locations consideration must be given as to the availability of actors, props, and equipment at these times and places.
4. The various scenes and sequences in each part of the production should be broken down and rearranged into a schedule that entails the following:
   (a) Schedule scenes to be shot together that are in the same general location.
   (b) Estimate the time requirement for filming each of the scenes in the production.
   (c) Compile a list of the actors, props, equipment and any special instructions or requirements needed for each scene or series of scenes.

Final Conference

Prior to the actual filming of the motion picture production, a final conference should be held. At this conference the production breakdown should be reviewed to test its workability, any loose ends should be tied up, and final problems settled.

There must be no doubt in the mind of any of the actors or technicians as to what is required. Each member of the crew must know, during each phase of the shooting, exactly what his job will call for and how it can be best accomplished.

Preshooting Technical Planning

The actual shooting of the picture should be relatively easy, provided that the preproduction planning has been carefully carried out and attention paid to each detail.

Before each day's shooting, the director (crew chief), cameraman, and other technicans should carefully study the script and dope sheets for that day's shooting, so they will know in advance just what is to be done that day.

If the crew is well oriented and informed, there should be no holdups in the shooting, nor ill-advised compromises reached on the spur of the moment because some detail of planning was overlooked.

To avoid delays in the shooting, several items must be taken into consideration during the technical planning:

1. When the equipment and props needed for the production are being assembled, all equipment and storage cases should be checked for completeness. This procedure reduces the possibility of leaving a vital or essential item behind when going out on location.

2. Examine and test all equipment and props to assure yourself that they are in proper working order.

3. Sufficient spare parts should be carried with the crew, especially if the film is to be shot at a remote location.

4. The emulsion speed and contrast of film will vary between batches so the same emulsion number should be used throughout the entire production.

5. Roll numbers should be assigned to each camera if more than one camera is working on a production.

6. Decide upon the shutter openings and filters to be used.

7. If both "F" and "T" stops are used, differences between the two should be resolved.

Uncontrolled Action Coverage

The coverage of the action in motion picture photography is either controlled or uncontrolled. Controlled coverage of the action is when every move of the subject can be predetermined and positively controlled. The type of motion picture photography most Navy cameramen will be called upon to shoot is normally of the uncontrolled action type.

Uncontrolled coverage of action means that the photographer has no control over the action that is taking place. In uncontrolled action photography the action is uncertain and unpredictable and cannot be directed.

Newsreel photography is an example of uncontrolled action. However, it becomes semicontrolled action when the photographer knows beforehand with reasonable accuracy when and where the action will take place along with what is to take place and how it is to be accomplished.

PLANNING.—First obtain as much information about the job and as far in advance as you can. This can usually be done by the following:

1. Obtain a conference or meeting with people in the know to find out what is scheduled and what will be required of the photographer.

2. If possible take a trip to the location, in order to plan shooting techniques and locate shooting positions.

3. Write down all details and plans in a logical sequence.

4. Pay particular attention to backgrounds, possible distractions, and lighting.

5. Next make out a shooting plan which includes a shot breakdown and a listing of the men and equipment that will be required. When making out a shooting plan remember to keep the other members of the crew informed. Also remember, the film editors need for overlapping coverage, and the availability of required personnel and/or equipment on the scheduled shooting date.

6. The proper filming, support, and lighting equipment, designed to do the job, should be obtained and used. This equipment should be thoroughly checked for proper operation and the possibility of a malfunction.

The camera crew should arrive at the shooting location as far in advance as possible. This enables them to accomplish the following steps:

1. To obtain and study any available plan of events and/or background information.

2. Time to make any necessary last minute changes to the shooting script and set up cameras and other equipment at the best possible locations.

3. Time to make a final check on proper operation of the equipment.

4. Arriving at the location early will also generally give the cameraman time to shoot establishing shots, and cutaways.

SHOOTING TECHNIQUES.—All crew members must work as a close team. Do not step or move any equipment in front of another camera that is already shooting or preparing to shoot the action. The use of additional cameras to take over the shooting enables the coverage to be continued without a lapse in continuity or a break in the action, if the camera that is shooting the action should lose the action, run out of film, or in case nonelectrically operated cameras become wound down.

When two or more cameras are used, screen direction (movement of the action) must be maintained between the cameras. For example, if one camera is positioned in such a manner that it films the main action moving either in a left to right or right to left direction a camera on the opposite side would film the same action but moving in an opposite direction.

Extreme angle changes between cameras must be avoided. The maximum angle change between cameras is 90° while the preferable change is 45°.

When the action is confined to a single area and/or long scenes are being filmed the camera must be tripod mounted. When used as a cut camera, or when mobility must be maintained, the camera will normally be hand held.

Before starting to shoot, the cameras must be standardized as to exposure settings, frame per second rates, film, and filters.

It is unlikely that you will have much time to focus the camera when shooting uncontrolled action events, so focusing must be rapidly estimated. Zone focusing is recommended as a method of accurately yet rapidly focusing a camera. For example, suppose that a 16mm motion picture camera having a standard (normal focal length) lens of 25mm is used. At an f/stop setting of f/8, if the camera is focused at 15 ft a depth of field coverage from 7 1/2 ft to infinity is obtained; focusing the camera at a 6-foot distance gives a depth of field of 4 1/2 feet to 10 feet, while focusing the camera at a distance of 4 feet provides a depth of field from 3 1/6 feet to 5 1/3 feet. It can be readily seen by this example that accurate focusing of the camera can be easily and rapidly accomplished when the depth of field tables for a particular focal length lens are utilized.

COVERAGE.–The most important thing in uncontrolled action photography is to show what is taking place. The motion picture cameras should be located in positions that will enable them to obtain the best possible footage of what happens as it happens.

The use of other cameramen to cover and complement the main action shots with close-ups, cut-ins, cutaways, and parallel action shots will provide the film editor with extra film footage of the event and makes it easier for him to edit the film into a more interesting and complete story.

CONTINUITY.–It is just as important to maintain continuity in action and between action with uncontrolled action as with controlled action. Knowing or having an idea in advance as to what the main action events will be makes it easier to plan for and cover the action in a sequential manner. In the construction of the shooting plan, a means of showing the action in sequences and connecting these sequences together should be contrived. Gaps in the action which in turn cause a break in the continuity of the story are present in most coverages of uncontrolled action events. These gaps in the action are usually the result of having to shoot intermittently while the action still continues. Often these breaks in action can be covered up by the use of inserts cut-ins, and cutaways. The two most frequently used inserts are covered in chapter 19 of the PH 3 & 2 Rate Training Manual, NavPers 10355-A.

Having a sufficient number of appropriate cut-in and cutaway shots enables the photographer to concentrate mainly on the highlights of the event.

Documentary and News Type Motion-Picture Coverage

In recent years Navy motion picture crews have been called upon to shoot an increasing number of documentary coverage assignments. Some of the recent U.S. naval operations covered intensively by documentary footage are:

1. Arctic and Antarctic operations and explorations.
2. ASW operations.
3. Naval missile programs.
4. The Vietnam conflict.
5. Satellite launches and recoveries.
6. World cruises.
7. Sea Lab operations.
8. Normal fleet operations.
9. Naval research and development briefings.

Most documentary/news coverage is accomplished by crews assigned from the Naval Photographic Center or from one of the two combat camera groups. At the present time the

Navy has two combat camera groups, one on the East and one on the West coast. The primary mission of these combat camera groups is to obtain complete documentary coverage of assigned subjects.

Even though you may not be assigned to a combat camera group (CCG) or to a crew operating out of the Naval Photographic Center (NPC) as a senior naval photographer you may still be assigned the mission of obtaining professional quality documentary coverage of assigned naval subjects if the need arises. Documentary films are concerned with the recording and interpretation of real events and subjects and serve one or more of the following objectives:

1. A training aid.
2. To record historical data, events, and facts.
3. Information; for example, naval research and development reports.
4. Entertainment; for example, travelogs.

The following discussion is intended for the purpose of providing the naval photographer with information he may find useful in obtaining not only documentary motion picture coverage but other types of motion picture coverage as well as still photographic coverage.

PLANNING.—The first factor to be considered in any photographic assignment is the planning and organization of the assignment. This includes determining the purpose of the coverage, what factors or areas are to be emphasized, and the desired extent of coverage. The original request may specify the type and amount of coverage desired; in many instances, however, it will not. In any situation the photographer must often rely upon his own good judgment based upon knowledge and possible previous experience with other operations.

The knowledge and background information necessary to become well informed and to assist you in doing a better job can usually be obtained from one or more of the following sources: Conferences with the participants for information and their opinions (these personnel should include the participating unit's operations officer and public affairs officer); operational plans; films including stock footage and/or completed productions shot on past or similar operations; research reading of literature dealing with past operations; plans and history of similar operations.

The photographer must keep himself informed on all aspects of the assignment, including possible operational changes.

TRANSPORTATION.—A frequent trouble source is the apparent nonavailability of transportation. Transportation will probably be arranged by your unit to the main shooting area or closest possible location to the main shooting area. However, you may often find yourself very much on your own, especially when in forward or advanced areas of operations. The problem of transportation becomes particularly critical when you are operating on a tight time schedule, and during the course of your assignment are required to travel to various shooting locations. For assistance with any transportation problems it is recommended that you contact the following:

1. MAC air terminals.
2. District transportation office.
3. Base and/or unit operations.
4. Boat pools.
5. Shore transportation pools.

RESEARCH.—Upon arrival at the assigned project, contact the commanding officer (or his representative) of the ship, squadron, or unit, or the officer in charge of the project you have been assigned for photographic coverage.

They are normally very interested in how you plan to present their command or project and what you plan on doing. They are able to provide you with more assistance than anyone else and quite frequently have some very good suggestions.

A good photographer, first carefully studies the situation and becomes completely familiar with its various aspects and operations. Make the necessary local contacts for shooting (camera) positions, technical advice/advisors, any additional miscellaneous equipment, electrical power, etc., and any additional personnel.

If you do not already have a shooting script it will be necessary to write one. When writing the shooting script keep the following in mind:

1. Camera locations.
2. Camera angles.

3. Assigning other cameramen to cover specific scenes and/or angles.
4. Screen direction.
5. Continuity.
6. Slating, roll numbering, and titles.
7. Shooting the action in a logical sequence whenever possible.
8. Keeping other members of the crew informed by giving them copies of the shooting script.

AERIAL MOTION PICTURE PHOTOGRAPHY

Naval photographers assigned to Naval Air Stations, aircraft carriers, cruisers, and various aircraft and helicopter squadrons are often called upon to shoot motion pictures from the air. Today's Navy has many requirements for aerial motion picture footage. Some of these uses are:

1. Weapons evaluation.
2. Public information.
3. Historical records.
4. Intelligence.

AIRCRAFT TYPES FOR AERIAL MOTION PICTURE PHOTOGRAPHY

Patrol type aircraft and helicopters are both suitable aircraft types to use as aerial motion picture platforms. The helicopter is however probably best suited for use as an aerial motion picture platform. It can be used with electrical or battery powered cameras. Extreme long shots or closeups can be taken, any suitable focal length lens can be used, and almost any camera speed used with the latest self stabilizing vibration-free camera mounts.

AERIAL MOTION PICTURE CAMERAS

Electrically operated motion picture cameras are usually more dependable and scenes can be of any length up to the camera's maximum film capacity. The minimum film capacity for 16mm cameras should be 200 feet.

Always use a normal or wide angle lens on the camera if a self stabilizing, vibration-free camera mount is not utilized. The effect of aircraft vibration on the image quality is exaggerated as the focal length of the lens increased. For best results a 16mm camera should use a 25mm focal length lens or less.

Motion Picture Camera Speeds

Aerial motion pictures are normally taken at 32-48 frames per second (fps). This reduces the effect of camera vibration, and keeps the target on the screen for a longer period of time for more detailed study, when the film is projected at the normal 24 fps. However, public affairs and news release films are normally shot at 24 fps and not above 32 fps. This is to prevent the illusion of speed from being destroyed.

Aerial, like ground, motion pictures require a complete shooting script. The shooting script should be discussed with the aircraft pilot, who will also be provided a copy. This discussion is to insure that the aircraft is capable of executing the proposed flight paths. The shooting script will adhere to sequential shooting techniques. Numbering the scenes enables the photographer to refer to the different scenes by number only when talking to the pilot.

The shooting script should contain the following necessary information: Target or scene; aircraft distance from target; aircraft altitude; and flight path of the aircraft. The aircraft should be flown at the minimum safe speed that can be achieved without vibration, in all air-to-ground motion picture photography.

Air-to-air sequences are normally executed by starting the camera at a long shot distance, and ending the scene with a closeup as the camera aircraft closes in on the target.

In the sequential shooting of air-to-ground subjects the first scenes taken are long shots (LS). The LS orients the audience and creates interest in the subject. The medium shot (MS), usually taken at a lower altitude than the LS provides the audience with a closer view of the subject, and identifies the subject. The final part of the sequence, the closeup (CU), is referred to as a pin-point. In the pin-point sequence the aircraft should be low enough to allow the target to fill the motion picture film frame.

The camera aircraft should not make a slow 180° turn while the target is being photographed. To do so will give the audience the erroneous illusion that the subject itself is turning.

If a properly executed 360° turn is flown over the target the target will appear to rotate on the screen when the film is projected. This is very effective in a pin-point sequence when a detailed view of the subject from all angles is required.

TELEVISION COVERAGE

The factors involved in shooting film for television and which will be covered in this section are: framing and composition, shot breakdown, time considerations, and shooting procedures.

FRAMING AND COMPOSITION

The construction of the TV picture tube (round corners or covers) and transmission cropping, limits the amount of usable area within the motion picture frame to the center 2/3. Thus, the main action and composition should be confined to this center 2/3 of the motion picture frame.

The camera being used when filming for television will show the proper field of view if properly equipped with a television format mask. (See fig. 12-11 in chapter 12 of this manual.)

SHOT BREAKDOWNS

The long shot ordinarily used to orient the audience is eliminated whenever possible. If used, one long shot (LS) established properly should suffice for several sequences. Television's low resolving power and definition, and the small size of television screens make long shots difficult, and dull to watch. When the film being shot is intended for television viewing, scene locations and audience orientation should be established through the use of medium shots (MS) and closeups (CU).

This takes thought and ingenuity but the use of identification signs and readily identifiable objects can be used to orient the audience and establish the location. Long static scenes should be eliminated by the use of closeups, cut-ins, and cutaways.

The action, when possible, should complete the shot breakdown. One method is to have the actors or action move from an LS into the camera field of view and end with a closeup.

SCREEN TIME

The actual length of time that the film will be shown on the screen should be determined, if possible, before the shooting so that appropriate coverage can be planned. If the screen time is short, it is useless attempting to cover all the details of a complex subject, and the action must be established more quickly; in other words, the shorter the screen time, the faster the tempo of the action must be.

Short screen times may require that the events be presented as a montage. The montage is an excellent way of getting an idea across as to what is happening without showing the complete action. A montage, however, should be used only when the available screen time is short. When the montage is used the screen direction must be carefully planned and the editor provided with a variety of shots.

NOTE: A montage is a product of creative film editing. The term signifies a sequence of separable shots which have been connected by the film editor in such a manner that the audience has the illusion that an event, time, or a journey passed in a rapid but seemingly complete manner.

Long screen times require the use of additional cutaways and cut-ins. If a long screen time is available it is best to match the action between scenes rather than use a montage.

LEAD TIME

The amount of time available between the filming of an event and its first showing to a television audience is referred to as the lead time. In situations where the lead time is too short to permit editing of the film in the lab, the editing is done in the camera during the shooting of the event. This procedure should be avoided whenever possible and sufficient time allowed for cutting and editing the film in the lab. Attempting to edit a large amount of film in a short time is very difficult and the final result could be a product not entirely satisfactory.

The best way to maintain the interest of an audience and insure smooth continuity of the film is sequential shooting with a minimum number of long shots.

FILTERS

The television reproduction of a scene is more contrasty than the actual scene so filters that will darken skin and/or sky tones are recommended.

TELEVISION LIGHTING TECHNIQUES

Long scale panchromatic films can reproduce approximately 130 different tones of gray; however, only 30 different tones of gray can be reproduced by television. As a result, the contrast of the television picture viewed by the audience is increased and there is a loss of detail in the picture. Consequently, high contrast lighting should not be used for either exterior or interior shooting. If the shadow areas are too dark, details in these areas will be lost, while at the same time the shadows will bleed over into the rest of the image area. The best lighting ratio for films shot for television viewing is 2 to 1.

Processing

If the lighting has been kept to a 2 to 1 ratio, the film should be processed normally so that it will contain its maximum range of tones. If the lighting was above the recommended 2 to 1 ratio, the film must be processed to a lower gamma. Additional motion picture lighting techniques are covered in a later section of this rate training manual.

TELEVISION PRODUCTION PROCEDURES

The procedures involved in producing a television film will be presented in a summarization, as follows:

1. Write the production outline. This outline should contain only the story idea and the screen time.

   a. Have the production outline checked and approved by the reqeusting authority.

2. Write the action outline. The action outline breaks the production outline down into general sequences, and covers narration and general camera techniques to be used in the shooting of the film.

   a. The action outline is examined and comments made by your superiors, not the requesting authority.

3. Write the shooting script. The shooting script includes shooting locations, narration, photographic ideas, etc., and is complete in all details.

   a. The shooting script requires the review and approval of both the requesting authority and your superiors.

4. Upon approval of the shooting script accomplish the photography.

5. After the photography has been accomplished and the film processed a work print and a rough cut is made and the film viewed and timed. This film requires the approval of the requesting authority.

6. Record the sound if this has not been done prior to this time. Insure that it matches the picture.

   a. If possible the sound should also be approved by the requesting authority before the final printing. The sound can be checked by recordings on tape or magnetic film so that playbacks are possible or by making a work print of the sound track and playing the picture and sound on separate synchronized reproducers

7. Make a print for approval and acceptance by the requesting officials. This print combines the picture and sound into a single print termed a composite print.

Distribution

Local Public Affairs Offices are authorized to make releases of film, from one to three minutes long to local TV stations. This release is to be of local interest only and only for local TV viewing.

Releases of national interest can be made only by The Chief Of Naval Information (CHINFO) via The Naval Photographic Center. The original materials (film, scripts, background material, etc.) of releases that are of national interest are to be sent to the Naval Photographic Center.

LIGHTING TECHNIQUES

There are no set rules to lighting. Each scene creates new lighting problems and must be individually considered. The photographer does not learn good lighting techniques by referring only to lighting charts or diagrams. He must study and practice both, to learn how each individual light and combinations of lights will affect a scene. Only when the photographer understands fully what each light adds to a scene and the reasoning behind its placement will he acquire a good lighting technique in motion picture photography.

EXTERIOR LIGHTING

When shooting motion pictures out of doors, the photographer is usually limited to arranging the scene in relation to the sun, the use of reflectors, or heavy, cumbersome lighting equipment designed for outdoor use that consumes tremendous amounts of electrical power.

The same exterior lighting techniques used for still photography can be applied when filming a motion picture out of doors.

INTERIOR LIGHTING

Indoor or set lighting has two major functions; first to supply sufficient illumination for correct exposure, and second to establish, contribute to, or establish a mood in keeping with the tempo of the scene. This second function indicates that the scene must be lighted in such a manner that it will appear both natural and visually interesting.

Lighting techniques are based on the fact that all subjects are viewed on a flat plane; thereby one must light the subject to show three dimensional form (length, width, and depth) Lighting continuity must be followed when illuminating a motion picture set.

Normal, low, and high key lighting are the three types used in motion picture lighting. Normal key lighting presents the subject in a natural light with both highlights and shadows. The highlights, while full, still contain detail. The exposure and development time for film exposed by normal key lighting does not require any modification, but remains normal.

Low key lighting is used for scenes when a feeling of restfulness with an air of mystery is desired. The entire feeling of low key will be destroyed if too many lights are used, so one or at the most two lights should be sufficient. Very little light should fall on the background. Highlights must not be so bright that important shadow details are lost and the exposure should be slightly under normal to avoid any strong highlights. Development time is normal.

High key lighting is useful when filming closeups or for feminine portraits. Best results are obtained when the subject has light colored hair, a fair complexion, and is wearing either white or light pastel colored clothing. The background must also be of a light color. The subject's face will record in a darker tone than the background to provide tonal separation. No deep shadows are present in high key lighting. The exposure should be slightly over normal while the development time will still remain normal.

CLASSIFICATION OF SET LIGHTS

Set lights are classified as key or modeling light, fill-in light, backlight, and background light. The effect of these lights and their placement are covered in chapter 4 of this rate training manual.

It is important that the photographer remember that too many lights can complicate or even ruin the desired lighting setup. It is better to use only one light if it is properly set up than three incorrectly or improperly handled.

Basic Interior Lighting Setups

There are six basic setups for interior lighting. These are front lighting, modified front lighting, three-quarter lighting, side lighting, back lighting, and triangle lighting. Front or flat lighting is recommended when a minimum of shadows or contrast is desired and for beginning color assignments. Two lights of equal brightness are placed on either side of the camera at approximately equal distances from the subject.

MODIFIED FRONTLIGHTING—This type of lighting is recommended for interior color setups where lighting contrasts are reduced. Modified frontlighting is similar to regular front lighting except that the fill-in light is moved farther away from the subject, to produce a 2 to 1 lighting ratio. This 2 to 1 lighting ratio is considered ideal for color photography.

THREE-QUARTER LIGHTING.–This is also referred to as 45° lighting. Three-quarter lighting is recommended for assignments requiring normal contrast and for closeups. It provides excellent modeling and form to the subject. The main or key light is placed at about a 45° angle to one side of the camera. The fill-in light is positioned on the opposite side and farther from the subject.

SIDE LIGHTING.–This type gives more dramatic effects and is recommended for special lighting problems. It is not recommended for color unless the photographer has had considerable experience in controlling contrasts. The key or main light is placed at 90° to the camera axis and at the level of the subject. The fill-in light is placed on the opposite side of the camera.

BACK LIGHT.–This light provides profile or "rim" modeling and is used to outline the subject with light for a more dramatic lighting. It is not recommended for color due to excessive contrasts. The back lighting effect will be nullified if the background is too strong lighted.

For back lighting a concentrated spot with barn doors is recommended. This spot is placed behind the subject, pointing toward the camera but not opposite the camera. The fill-in is placed near the camera to fill in the heavy shadows. Dependent upon the results desired, some increase in exposure may be required.

TRIANGLE LIGHTING.–This sytem of lighting was developed by the General Electric Company for interior shooting. When the lights are correctly positioned, a 2 to 1 lighting ratio is obtained. Both lights must be of the same size and intensity. The fill light is put into position first. It is placed as near the camera as practical and on the opposite side from the key light. Measure the distance from the key light to the subject. Then measure an equal distance at a right angle to the subject and mark this position. Place the key light exactly halfway between the fill light and the marked position raising it slightly above the height of the subject. The back and background light, if used, are positioned in the usual manner.

Illumination Control and Depth of Field

The correct procedure when setting up any of the lighting types is in the positioning of both the key and fill lights, together with the extra lights used for additional separation.

In positioning the key light the nose and lip shadows are important. The fill-in lights position is determined by the desired degree of contrast. When two or more lights are used avoid confusing or contrasting shadow patterns. A 2 to 1 lighting ratio should be maintained for color and not over a 4 to 1 for black and white. High or low key lighting is not recommended for any lighting setup other than special or dramatic.

Controlling the illumination of the set is best achieved by first determining the area and depth that must be covered in the scene. Set the exposure meter on the shutter speed of the camera and the desired f/stop. Next begin to light the set, bringing the overall light level up to the indicated light level shown on the meter. Maximum use should be made of f/stops to maintain adequate depth of field with the slower color films. This requires carefully choosing the position of the key light to control the intensity of the illumination level.

Large, high intensity floods or spots should be avoided by the color photographer when he is shooting closeups. These large lighting units produce considerable heat which could damage the material being photographed as well as cause physical discomfort to the subject.

Color Lighting Techniques

When selecting background colors the following factors should be considered:

1. Avoid bright colors that detract from the subject.
2. Select background colors that complement the subject.
3. Do not place the subject too close to the background. This is to prevent undesirable

colored light from being reflected onto the subject.

Pay particular attention to the contrasts (ratio) between the highlights and shadows. The recommended ratio for color is 2 to 1 and the maximum ratio is 4 to 1.

Although the lighting ratio is low (2 to 1) a pleasing contrast is achieved if the natural color harmony and contrast between colors are maintained.

DETERMINING EXPOSURES AND COLOR BALANCE.—Correct exposure can be determined by the following two methods which, if properly used, will insure satisfactory results:

1. The use of a reflected light meter which indicates the amount of light that is reflected from the surface of the subject.
2. The use of an incident light meter, which indicates the amount of light that is falling on the subject.

The incident light method is preferred in motion picture photography. The use of a color temperature meter is recommended in color photography for accurately controlling color temperature and balancing lighting units.

Color correction filters can be used on the camera lens, or voltage regulaters can be used to balance the light to the film, or a combination of both can be used in achieving correct color balance. It is important that all lights used be matching for color balance.

SOUND RECORDING TECHNIQUES

The picture image and the sound are recorded at the same time on the same piece of film in single system sound. The film must be moving at a constant unvarying speed at the point where the sound is recorded. However, in order to obtain the illusion of motion, the picture image must be moving intermittently at the aperture. This creates the necessity of separating the recorded sound from its corresponding picture image. This displacement has been standardized with the sound track being 26 frames ahead of the picture frame on 16mm film. The tolerance for this displacement is ±1/4 frame.

Single system sound is the fastest method of producing a sound film, the major use of single sound being in the filming of timely news events. Single system sound is not, however, used in the production of a feature film because of problems encountered during editing; lower quality of sound; and the difficulties that are encountered when attempting to combine dialog, sound effects, and music with the picture all at the same time. Single system sound has been largely replaced in the Navy with double system sound.

DOUBLE SYSTEM SOUND

In this method the picture is recorded on photographic film in a camera but the sound is recorded on a different medium in a separate sound recorder. Magnetic sound recorders are the most commonly used today, and will be discussed later in this chapter.

Double system sound has many advantages over single system sound. Some of these advantages are listed as follows:

1. A magnetic sound recording can be erased and the magnetic recording medium used again.
2. It is easier to edit and with better results since the 26 frame difference between sound and picture is eliminated.
3. A magnetic sound track can be audited immediately and checked for quality.
4. It is easier to mix a variety of sound tracks (voice, music, sound effects) together later in the studio, than on the film during the actual shooting period.
5. No processing of the sound track is required so one source of distortion is eliminated.

Disadvantages of the double system sound are that synchronization must be maintained between the camera and the sound recorder. And synchronization must also be maintained during the editing and screening of the work print.

In double system sound there are two types of recordings: synchronous and wild (nonsynchronous).

The picture and sound are recorded at the same time in a synchronous recording. A sync reference point is placed on both the sound track and film by a clapstick or electronic clapstick, that is closed after the camera and recorder have both reached sound speed.

Examples of synchronous recordings are scenes with dialog and scenes with music where the musicians and/or vocalists are shown in the scene with the sound being recorded at the same time as the picture. The camera and recorder must be kept in perfect synchronization by means of a sync motor and a sync pulse, as the average person can detect ±2 frames out of synchronization.

When the recording is made without any relationship to the camera so that it does not sync with the picture during the recording it is referred to as wild or nonsynchronous. Examples of this type recording are sound effects, narration and background noise. In a wild recording the sound and action on the film are synchronized together during the editing.

To prevent any dead spots in the sound track and ensure that enough has been recorded to cover the scenes shot on that location, background noise or room silence should be recorded on all locations.

PLACE AND TIME OF RECORDING

Sound can be recorded either on location at the time the scene is being shot, prior to shooting the scene (pre-sync recording) or after the scene has been shot (post recording). Sound recording on location should be avoided whenever possible, because of the many extraneous sounds and lack of acoustical control which makes conditions usually far from ideal. If it becomes necessary to record the sound on location, always record background sounds for use in editing.

A means of obtaining better sound quality is pre-sync recording. The sound is recorded in a studio with maximum control, using a recorder having a synchronous motor. The recorded sound is then played back and the scene shot to the sound, with the actors pantomiming to the sound. Pre-sync recording has the following advantages: no retakes caused by sound problems; acoustics are not a problem so the set is easier to construct; and retakes are faster because there are no problems with having to record the sound and picture at the same time.

Another method of obtaining a better quality sound track than can be obtained by recording on location is post recording. In this method the sound is recorded after the picture has been shot. The picture is then projected and the sound recorded to the picture. Many rehearsals are usually needed as the actors whose voices are to be recorded must speak their lines in sync with the lip movements of the projected image.

MAGNETIC SOUND RECORDINGS

Magnetic recorders more commonly referred to as tape recorders, are used in double system sound to provide a synchronized sound track. A 1/4-inch wide magnetic tape is usually used as the recording medium. Magnetic tape, however, is manufactured in widths to over 2 inches; the wider tapes are used for special purposes such as video tape recorders.

The base for magnetic tape is usually cellulose acetate, mylar, or polyester. Mylar and polyester bases are the thinnest and strongest. This allows more playing time per reel; however, their strength permits them to be stretched considerably before breaking, adversely affecting the quality of the sound. Mylar and polyester base tapes can also damage the equipment should a jam occur.

The accepted international standard speed for magnetic recorders is 15 inches per second (ips). This speed provides the best frequency responses. When sound is being recorded for motion picture work, the recorder is usually run at 7.5 ips. This speed conserves tape and also provides good frequency response. A third recorder speed is 3 3/4 ips; this speed is not used when a high quality of sound is required (for example, music) but can be used for dialog.

Reducing the running speed of a magnetic recorder reduces the signal to noise ratio (S/N) and decreases the frequency response. The higher the signal to noise ration, the better the quality of the sound. Professional magnetic recording equipments have an S/N between 55 and 70 decibels (db).

Frequency response is dependent upon the linear speed of the tape through the recorder and the size of the gap in the playback head of the recorder.

The higher the speed at which the recording medium is recorded, the longer the wavelength of the recorded audio signal. The narrower the gap in the playback head of the recorder, the higher the frequency that can be recorded. This is because the highest frequency that can be recorded is one whose wave length is equal to the width of the gap.

Magnetic tape recorded and played on professional magnetic recording equipment has a typical frequency response of 40 to 15,000 Hz at 7 1/2 ips.

Care and Storage of Magnetic Tapes

Print-through will likely occur if the magnetic tape is improperly stored. The faint echo heard when the recorded sound (magnetism) on one layer of tape is transmitted to the next layer of tape is referred to as print-through. Print-through will likely occur under the following conditions: Optimum storage humidity is 50 percent; decreasing the humidity increases the possibility of print-through. The possibility of print-through also increases when the storage temperature is over 60°F. Recording the audio signal at a high level of intensity increases the possibility of print-through.

The thicker the base of the recording medium, the less chance of print-through. Print-through can be prevented by keeping the tapes loosely wound, rewinding at frequent intervals, and keeping them stored under optimum conditions.

A container made of either MU-metal or of radiometal should be used when shipping recorded magnetic materials as these containers will not retain magnetism.

Erasing the Tape

Any magnetic material should be erased before it is used. Degaussing, demagnetizing, and erasing are all synonymous terms.

It should never be assumed that a roll of tape to be used for recording is free of all sounds and noises. The tape may have been used before or if it is a new roll it could have picked up noises if passed through a magnetic field. The erase head on the recorder does not always remove all traces of noise and sounds; instead, use a bulk eraser.

PRINCIPLES OF OPERATION

The recording head of a magnetic recorder is an electromagnet, having two poles with a narrow gap between them. The incoming audio signal being recorded causes a fluctuating magnetic flux (field) to be produced in the gap between the poles of the electromagnet. The louder the audio signal being recorded, the higher the voltage and the stronger the magnetic flux. The fluctuating magnetic flux will cause the iron oxide particles in the emulsion to line up in a corresponding magnetized manner.

When the tape is played back, the inherent magnetism in the recorded tape will produce a varying flux in the gap of the playback head (also an electromagnet). This varying flux induces a small fluctuating electrical current in the coil. This fluctuating current is the audio signal. The azimuth, placement, and gap of the playback head must line up exactly the same as the recording head or the quality of the sound will be diminished.

The playback head follows the recording head on professional recording equipment. This feature allows the operator to monitor and check the quality of the sound being recorded. An erase head (when included) is installed in front of the recording head to erase previously recorded sounds and noises, when the tape recorder is in the record mode of operation. The erase head cannot be depended upon to completely clear the tape of previous noises and sounds; therefore it is not found on many professional recorders.

Synchronization Methods

The recorded magnetic tape and motion picture film must be in precise synchornization, if the projected image is to be matched with its corresponding sound. This process of synchronization is accomplished by means of synchronous motors and/or sync pulses. A synchronous motor operates at a constant speed controlled by the cycle rate of the AC power source. All equipment will operate at the same speed if synchronous motors are used and if they draw power from the same power source. After the film and sound track have both reached sound speed a sync mark is placed on them both by means of a clapstick or electronic clapstick.

A second method of synchronization is through the use of pulse synchronization. This sync pulse is taken from the power supply if a synchronous motor is being used; if not, the pulse is taken from the camera motor. The sync pulse, recorded on the sound track (magnetic tape) at the same time as the audio signal, furnishes a speed reference signal during playback of the sound. If the recorder is operating at a constant speed the spacing between each pair of pulses will be exactly the same. If the speed of the recorder slows down, the spacing between the pulses will decrease. If the recorder speeds up or if the magnetic tape stretches, the spacing between the sync pulses will increase.

Any variation in the sync pulse signal can be read and speed adjustments made to the playback unit when the recorded sound is transferred to another recording.

MOTION PICTURE EDITING

The purpose of motion picture editing is to tell a clear and coherent motion picture story. Most motion picture footage is not shot in the same order in which it will be presented to the audience. Therefore, it is necessary to cut and rearrange the scenes in their proper order. This requires the deletion of unnecessary footage, and unusable film.

The tempo of the film is very important to the mood of the completed film as it assists in governing the audiences interest and emotions. It is best to cut the film scenes too long the first time, and then recut if necessary, than to cut them too short the first time.

FILM EDITOR

The film editor is another of the technical members of the staff chosen to transfer the printed work into a pictorial presentation. He remains at the laboratory working with footage as it comes from processing. An important function of his daily routine is to view the "rushes" or "dailies" at the end of each working day.

Editing film is an assembling process. When performed artfully, it will give perspective, interpretation, and drama to otherwise meaningless and emotionless separate photographic shots. Day-by-day the exposed film is processed in the laboratory. It is then sent to a screening room along with the sound track recordings of the day's takes. Here the editor and others of the production staff gather for the showing, called "viewing the rushes."

The editor studies the footage until he knows it thoroughly. Then he takes these separate bits of film that are without meaning individually, and blends them into a rhythmic, coherent pattern. To produce the desired effect or impression on the audience, the editor's skill and ability must be of the highest type.

The real measure of success of an editor is his ability to keep his work from being noticed by the viewing audience. It is the common opinion of film editors that any cut that is noticed is a bad cut. Cuts that may be described as good are those that go unnoticed by the audience.

The film editor must be capable of selecting the best scenes and arranging them in logical order to tell the story. He must put them together so as to obtain the greatest value out of the work already performed by the director, actors, and the production crew.

FILM EDITING EQUIPMENT AND SPACES

Because of the nature of their function, editing rooms must be kept spotless, and no smoking should be permitted at any time. All unusable film should be placed in a film bag for possible silver reclaiming.

The following items of equipment are required for editing purposes:

1. Editing gloves: The gloves should be made of soft white cotton. They should always be worn when handling film to prevent scratches and fingerprints.
2. Film splicers: The film splicer is either portable as for example the Triad 16-35mm or on a pedestal like the Bell and Howell 16-35mm splicer. A film splicer is used for joining together lengths of motion picture film or magnetic film during editing or when repairing breaks.
3. Film viewer: The viewer has a ground glass screen and intermittent action. This allows the editor to view and follow the action on the film.
4. Film table: These tables have a lighted built-in viewing glass and numbered pins or slips for hanging scenes in their proper order.
5. Motion picture projector: A standard basic projector is used to view the film before and after the editing. All projectors are threaded basically the same, with theading diagrams

usually etched or painted on the projector body or on an inside door. Positive film is threaded clockwise, heads down with the emulsion towards the projector. Negative and reversal films are threaded clockwise, heads down also, but the base of the film is towards the projector.

Safety

In addition to the general safety precautions mentioned elsewhere in this training manual, the following rules, particularly applicable to the editing phase of motion picture production, are noted:

1. Potential electrical shock should be reduced by the use of a three prong grounded plug on all electrical equipment.
2. Always screw the cap back on the film cement when it is not actually in use and avoid any prolonged breathing of the vapors.
3. Use extreme care when lowering the blocks of a pedestal splicer to prevent the possibility of finger amputation.
4. Replace the projection lamp whenever the blackened area extends below the top of the filaments.

MOTION PICTURE EDITING PROCEDURES

The editor works with a positive work print from the original motion picture footage. The first step in the editing procedure is the breakdown. First project and view all motion picture footage shot on the assignment, to get an idea of the type and quality of the coverage and an indication of scenes that may require reshooting. Notes should be taken as necessary to assist in the editing.

Cut each scene apart and rearrange in proper order, by rolling them on individual small rolls on cores or reels. Remove at this time all unusable scenes such as head or scene slates. Do not remove more footage than necessary; it may be needed later. Label each roll with its scene and take number according to the script. Then make a breakdown log as you proceed. The breakdown log lists the rolls by scene and take number, and includes the beginning and ending edge numbers of the film so that the rolls can be readily identified.

Follow the script or shooting outline to determine the proper sequence and hang the scenes in their proper order on the editing table pins, or stack the rolls in bench trays in scene number sequence. Place footages which are obviously no good in cans marked "out-takes." Do not throw this film away until after the film has been completely edited.

Splice the film sections together scene by scene in their proper sequence on a reel. Work from the script so that you can read the narration and instructions. Project the film to insure that the scenes have been placed in their proper order and to obtain a better check of quality. Time the various scenes.

Cut the scenes to their approximate scene length and match the action between the various scenes. Project the film again, taking notes for further editing. The only accurate method of determining correct scene length is by projecting and viewing the film.

Cut the scenes to their proper length (smooth cut) eliminating all overlapping action and matching as much action as possible. Gaps in the action can be covered or long scenes shortened as required by means of insert shots. Resplice and project the completed product to locate any errors in editing.

The film should now be ready for the final editing and cutting. There are three types of cuts: continuity, compilation, and cross cutting.

Continuity cutting consists of matched cuts, in which continuous action flows from one scene to another, and cutaways, in which the action shown is not a part of the previous scene. Factors to be considered in continuity cutting are the following:

1. Continuity of screen direction, as for example object and/or body motion (hands, feet, eyes, etc.).
2. Continuity of action. This is the counterpart of screen direction and requires precise cuts at the exact frames from scene to scene. Continuity of action is used to match types of action in montages and to show or explain logical reactions to action.
3. Continuity of environment should show gradual changes in the seasons of the year, locations, and the sun's position (shadow length of surroundings and familiar objects) unless a transition shot is used.
4. Continuity of timing is obtained by the use of short scenes for fast action or pace and

long scenes for slow action or pace. The buildup of pace should be gradual, starting with long scenes and gradually shortening them. It is best not to have too great a change in scene length within an idea. It is however permissible to radically change scene length when going to a new mood, after having made a point or when changing location.

5. Continuity of angles help to set the mood by either accenting or minimizing the subject and indicating the mood of the scene. Any changes in the angle of viewing should be made gradually, to avoid confusing or loosing the audience.

6. Continuity of lighting: The lighting ratio and type within a sequence must remain the same unless a reason for the change is shown. The lighting continuity of stock scenes and special effects photography must match the other motion picture footage.

The second type of cutting is compilation. This is the use of random shots held together by narration or commentary. It is necessary because of the snap shot nature of newsreels, documentary reports, history, or travelog type films, to use continuous narration to hold the scenes together. Without audio explanation on the sound track to hold the narrative together and propel the scenes, the audience would be able to make very little sense out of the film.

The third type of cutting is referred to as cross cutting. Cross cutting is the parallel editing of two or more events in an alternating pattern. Cross cutting has one important characteristic. It can be used to connect any event happening anywhere with any other event. Cross cutting can be applied for any of the following:

1. To heighten interest.
2. To make comparisons.
3. Provide conflict.
4. Increase tension.
5. Heighten suspense.
6. Depict contrast.

In summary, all of the shooting techniques of the cameraman apply to the editor. Editing is a creative process requiring the use of imagination in telling the story. The editor develops a smooth flowing story to obtain and hold the attention of the audience by the following:

1. The audience is oriented as to the who, what, when, why, and where of the story at the beginning.
2. Seeing that there is a smooth transition from scene to scene and sequence to sequence.
3. Proper use of the long shot, medium shot, closeup, and extreme closeup sequence to establish or reestablish the audience.
4. Maintaining continuity throughout the film.

The editors objective is to obtain and hold the attention of the audience throughout the picture. If the editing technique or special effects lose the audience, they are of no value.

Sound Editing

The tools required to edit a sound motion picture, whether it be a 20-minute instructional film or a 90-minute color epic, are many and varied. Editorial rooms are equipped with reels, rewinds, flanges, "gang" synchronizers, scissors, film cans, bins, racks, vaults, two types of splicers (hot and cold), complicated viewing machines known as Moviolas, paper clips, tape, acetone, a few dozen pairs of white cotton gloves, and a number of other odds and ends.

The Moviola is a miniature projector of both sound and picture that is controlled by foot pedals and/or hand-operated switches. It allows the editor to run the print either forward or backward at any speed he chooses while he watches the action on a square ground-glass screen, and listens to the sound delivered through a small speaker or earphones.

The pictures appear in full motion on the screen in exactly the same position in which they will later be seen on a full sized screen. The editor can thus visualize the final results of his work, although the final evaluation must be made on a screen to obtain the full impact of the film.

When the rushes (made from the negatives shot daily) arrive in the editorial department from the laboratory, the editor's first job is to trim these segments of film in such a manner that they may be viewed in scene continuity. At the same time similar prints of the sound track film are roughly edited and synchronized.

In many instances the sound effects tracks and music tracks have been recorded at separate times from the picture image. For purpose of this discussion, you can assume that the sound track is being recorded along with the picture.

Therefore, the basic voice track has arrived in the cutting room at the same time.

In single system sound, scene changes must be well planned and rehearsed. Usually the complete scene must be reshot, for if any picture frames are removed, the sound track directly adjacent to the picture will also be removed.

When the film is run through a projector the sound is 26 frames ahead of the picture. After the director calls "action" a slight pause is necessary to allow the required 26 frames to pass through the sound head before the action or speech begins. At the end of each scene or "take," a 26-frame "pulse" or "silence" is necessary. This is to permit the picture that is 26 frames behind the sound to pass the sound head. The silence at the end of the scene or take should be a natural pause in the action.

It is necessary to opaque all splices in the sound track areas of the film. This is necessary because the clear areas produced by scraping the emulsion for splicing will cause an audible noise when passing through the sound reproducer. Opaquing the splices in the sound track is accomplished by the use of a special black varnish ink, or by applying a small specially made triangular or diamond shaped sound track blooping patch over the clear spliced area of the sound track.

DOUBLE SYSTEM SOUND EDITING.–It was mentioned earlier that double system sound recording involves, at times, the recording of several different sound tracks, such as dialog, music, and special effects. These separate sound tracks must be combined into one master sound track. However, before any combining or mixing of the sound tracks can be done it is necessary that they be edited to match the picture.

Double system sound editing requires the use of white perforated tape instead of film cement. To prevent a click from occurring when the splice passes over the sound head, the cut must be angled so as to provide a diagonal butt splice. The edges of the film must be perfectly alined and there must be no space or overlap between the butted ends.

A synchronizer is used to keep the sound tracks and work prints in sync when editing and to keep the work print and negatives in sync when cutting the negative for printing. Line up the picture sync point with the audible sync point on the magnetic film. This is accomplished with the aid of the clapstick or the electronic clapstick.

The sound sync mark is located by turning the volume of the sound playback unit up and turning the viewer by hand. The start or end of any sound can be located in this manner. After the sync mark has been found, turn the volume down. Next put a visible sync mark on the magnetic track and label the sound track with the scene and take number. Splice all scenes together, maintaining sync in the approximate order in which they will be edited. Project the rushes in sync with the sound, studying the film and sound track to determine how it is to be edited. The picture and the sound track are edited at the same time, the picture being edited by the previously mentioned techniques.

When the picture is marked for cutting, the sound track is normally marked and cut at the same time, making the cut between words and musical notes. Remember the frame loss caused by the splicer when maintaining sync.

SYNC MARK.–The head and tails sync mark is a punched hole, preferably round. It should be 10 feet from the start of the first sound or picture.

An X is usually marked at the head end of each scene. This X is placed on the picture frame with a light colored grease pencil and on the sound track with a nonsmear ink or low contact tape.

SLUGS.–These are pieces of opaque film used to replace damaged film. A slug must be the exact length of the damaged film it is to replace. It is put into the work print so that the editor can easily spot and replace the damaged film.

SPACER.–This is any kind of photographic material (normally scraped positive film) cut into a magnetic film sound track in order to maintain sync and save magnetic film. The splice is made so that the base of the spacer is on the same side of the sound track as the emulsion of the magnetic film. When splicing an insert into a dialog track, insure that it is exactly the same length as the portion of the scene that it replaces. It is possible with inserts to increase or shorten pauses, add or subtract words, and in some cases even parts of words.

CUE SHEET.—This is a set of instructions to the sound mixer made up during the editing phase by the editor. As the track is edited, information is entered on the cue sheet in appropriate footages, symbols, and notes. The notes contain information on the control of the existing track.

CUTTING ORIGINALS

After all the material required to complete the final editing of the work print has been inserted, the most vital step in the editorial process is ready to get underway. This is the cutting of the original film to match the work print; this is accomplished by the use of the edge numbers. From this final cutting a new master positive print is made which includes all the sound.

The production is now complete. However, a number of internegatives are required in order that the release prints may be produced in volume. The number of internegatives printed will depend on the distribution of the picture.

PROCESS PHOTOGRAPHY

The term, process photography, includes the varied optical and special effects required to complete every professional motion picture that is produced. Among these are dissolves, fades, wipes, montages, titles, miniature work, and trick shots that involve matting and multiple exposure. The process photography department has the responsibility for photographic requirements that call for the combinations of real people and animals with photographs of cartoons or puppets and the combinations of photographs of scenic paintings with photographs of real people, animals, and sets. This latter technique is known as process screen or the rear-projection system.

Optical effects are the punctuation marks of the screen. They bear resemblance to the period, the comma, the exclamation point, etc. Fadeouts, fade-ins, dissolves, lap-dissolves, and wipes are excellent examples of this statement.

The fadeout can be compared to the lowering of a curtain on a scene or act in a play, or even the end of a chapter in a book. The fade-in represents the raising of a curtain on a new scene. The dissolve is compared to the comma in writing, in that it indicates the shifting of attention to a related thought in the film and may be used many times in a single picture as one scene changes smoothly to another.

When using the lap-dissolve, the fade-in of a scene is superimposed on the fadeout without allowing the image to disappear completely before the following one appears. The wipe takes the action suddenly from one point to another within a series of frames; it is the exclamation point.

The film editor, as already noted, tells the story by using each of these shots as effectively and interestingly as possible in order that the elements of the picture (visual image, sound, dialog, and music) will all blend smoothly.

Special effects work is usually accomplished after the actual shooting is over. It is filmed on sound stages or in rooms which have been specifically planned and built for the requirements of the picture. The crew that performs that work is not necessarily the original camera crew on the production. Process photography crews are teams of individuals who have devoted their energies and knowledge of photography to this special kind of work. In the civilian motion picture business, much credit is given to these men for their contribution of the many new ideas, inventions, and innovations which are incorporated into the production of modern cameras.

Many of the special effects discussed here are secured through the use of the standard 16mm and 35mm motion picture camera, either by itself or with simple or readily available accessories. However, the majority of the effects require special apparatus, which, at times, must be designed and built on the job. The most widely used equipment for the production of optical effects includes the optical printer, rear-projection equipment, animation camera and the title stands, and miniature models.

REAR-PROJECTION SYSTEM

Rear-projection or process screen photography is a process that consists of composite photography used as a means of supplying backgrounds for the action of film which is being photographed on a sound stage rather than on location. One could say the background scenery is brought to the studio photographically on film rather than transporting the cast, company, and equipment to the distant location site. More specifically, the rear-projection system is a method whereby the foreground action can be made to superimpose with previously photographed scenes.

SCENIC BACKGROUNDS are generally huge canvas backdrops cleverly painted in either black-and-white or color so they will match and blend with foreground settings. The purpose of the scenic backgrounds is to reproduce location scenery that would be economically unsound to produce through the location filming method.

Scenic backgrounds are strung across a set or even the entire stage so as to simulate stationary interior or exterior settings, whichever is required by the script.

PHOTOGRAPHIC MURAL BACKGROUNDS are another economical approach to filming. This technique consists of the use of continuous-tone photographic murals which will simulate exterior settings. These are produced by the still department from still negatives taken at the location site.

Photographic murals are most commonly used when a scene that is to be shot on an interior set (such as an office or conference room) requires a view of the actors at an angle that will show a window at their backs. Naturally, the camera will be situated so that the outdoor background (a street or other buildings) will come into camera view through the window. Scenes aboard ship will often include a bulkhead with portholes through which the sea and horizon may be seen.

TITLE OR ANIMATION STANDS

Practically all audience-viewed motion pictures require a title, along with credits, as they are called in the motion picture business. The title, of course, is exactly what the name implies, while credits may be defined as the names and departments of those individuals who have executive responsibility for the finished product.

Titling can be an extremely complicated task, applying all manner of optical effects; or, it can be relatively simple, with title and credit lettering merely superimposed over a suitable background. The scope of this work will depend upon the production budget as well as the subject matter of the film.

Most of the intricate title and transition effects are accomplished on the optical printer; however, many of the simpler effects and special transitions may be performed on a unit called a title or animation stand. The animation or title stand is composed of a camera mounted in such a way that it can photograph film, title cards, drawings on celluloid, and block letters either by transmitted or reflected light.

The machine includes an easel positioned in the horizontal plane below the camera. The material to be photographed is mounted on the easel with the camera shooting down toward it along an optical axis. The camera can be driven at a wide range of speeds, thereby allowing for a variety of effects.

Films that incorporate effects titles superimposed over action or scenery, (i.e., a situation where the actual setting appears behind the title and credit lettering and then dissolves into the plot) are made by a process of double negative exposure from a title-credit positive and a scenic or action positive. The first one was previously prepared by exposing the film to title and credit cards.

This type opening has no end of possibilities and variations so far as artistic achievement is concerned; however, the cost is prohibitive in military motion picture productions. The requirements for the less intricate Navy motion picture titles may be found in chapter 8 of the U.S. Navy Manual of Naval Photography, OpNav Instruction 3150.6 (Series).

MINIATURES

There is no limit to the combinations of cinematic effects that can be devised through the ingenuity of the photographic experts. Another of these techniques that produces unusual effects is the use of miniature models. Generally, miniatures are employed to produce the illusion of reality to satisfy the audience's desire for the spectacular and sweeping action that cannot in any other way be brought to them. Models cause the audience to experience the feeling of "on-the-spot" participation in an event or action.

Specific procedures or directions to follow in process photography which involves the use of miniature models cannot be set down in a standard step-by-step fashion. Each situation has its own problems and complications which are unique to the occasion or to the situation.

In many cases, miniature work is filmed outdoors. The movements of the miniature model are slowed down by operating the camera at higher than normal speeds. In full scale this would be slow motion; with miniatures, it is about right.

The correlations between the size of the miniature, the speed with which the action takes place around it, along with the angles of photography, are determined in advance by mathematical and experimental processes. When properly carried out, the scenes and effects that ensue from the use of miniatures will almost invariably convey an exciting and convincing illusion of reality.

An interesting aspect to miniature or model work is that rear-projection can be used as effectively in small scale as it is in full scale. Miniature rear-projection screens have been devised which can be incorporated into a miniature setting, supplying the background sea, sky, or action in direct proportion to the foreground scale.

SUMMARY

As you have seen in this chapter, the production of a sound motion picture requires the services of many allied professions. Hence, it has been necessary to insert brief discussions covering subjects that would ordinarily seem to be unrelated to photography.

The outstanding difference between military picture production and civilian production does not lie in the area of mechanical ability or technical skill on the part of the photographer, but more specifically, in the area of overall production scope. Generally speaking, the variety of subjects mentioned in this chapter has some application to a degree during the preparation for and the filming of a service produced picture.

Therefore, a brief discussion of the many aspects of production such as appears here, can only serve as a pattern for the first class or chief petty officer who may at some time during his career in the Navy be called upon to perform the duties of a motion picture production crewmember. For a more thorough understanding of the entire field of production, it would be advisable to consult civilian publications on the subject which are to be found in some station libraries. Also, invaluable knowledge may be gained by observation; that is to say, study the techniques and methods put to use by civilian moviemakers, while viewing an entertainment type film.

CHAPTER 14

MISCELLANEOUS PHOTOGRAPHY

Navy photographers frequently encounter special situations requiring a variety of techniques and equipment. Among these special situations, the following are discussed in this chapter: Underwater photography, testing photographic lab and field equipment, gunnery photography, and adverse weather photography.

UNDERWATER PHOTOGRAPHY

Underwater photography is now an accepted part of naval photography. It is used for reports on hull or screw damage, many types of underwater survey work, and to meet the great demand by news media for public information type pictures of the Polaris and nuclear powered submarines, as well as the Sea Lab projects.

Underwater photographic capabilities are maintained by many specialized groups and units. The largest and most versatile are the Atlantic and Pacific Fleet Combat Camera Groups at Norfolk, Virginia and San Diego, California.

These units have the newest underwater cameras and equipment. The Naval Photographic Center in Washington, D.C. has a capability for testing and evaluating new equipment. Technical bulletins are published and distributed by the Naval Photographic Center, giving invaluable technical data on the most reliable cameras and accessories.

The problems encountered in transporting a camera under the sea and operating it successfully are so different from those which are encountered on the ground and in the air that new techniques have been developed to cope with them. Some of the problems, such as low light intensities and color balance due to the color of the surrounding water, are basic. Another problem which is encountered in underwater photography is the actual operation of the equipment.

Waterproofing of a camera is not as much of a problem now as in the past. There are any number of underwater housings being manufactured for all types of cameras, from the simple 8mm home movie type to the more professional 16mm and 35mm Arriflex. Underwater TV systems are also available in the more specialized technical units.

In this type of photography, the photographer is entirely dependent upon his own resources, due to the extreme variety of physical and optical conditions which are likely to be encountered. Most underwater housings are built for specific cameras. As in all other work, one must use the right camera for the work that is to be accomplished. Any adjustments or modifications to housings and cameras are as a rule very minor.

CAMERAS

The Navy has a wide variety of underwater cameras. Table 14-1 is a list of the most common underwater cameras.

Any camera can be waterproofed for underwater use, but certain features are desirable if ease of operation is important. These features are:

1. Automatic film advance and shutter cocking.
2. A large film capacity so that the maximum number of pictures may be taken in one dive.
3. Large and easily manipulated controls, for ease of operation with or without gloves.
4. A lens speed of at least f/3.5, with f/2.7 being more desirable.
5. A wide angle lens.
6. Compactness.

Table 14-1.—Underwater cameras.

Trade name	Type camera	Film size	Capacity
Nikon (Nikonos)	Still	35mm	36 exps.
Rolleiflex (Rolleimarin)	Still	120mm	12 exps.
Simpson Hall (Filmo)	Motion picture	16mm	100 ft.
Simpson Hall (TV)	Television	—	—
Teledyne (DBM-5)	Motion picture (64 to 500 fps)	16mm	400 ft.
Rebikoff (M-123)	Motion picture (Filmo movement)	16mm	100 ft.

Figure 14-1 shows the Nikonos camera that incorporates all the features listed above.

Not only is this camera suitable for underwater use, but it is also ideal for use where other cameras might be damaged, i.e. when photographing in inclement weather (rain, snow, dust) or where flying debris might strike the lens (fires, riots, construction).

The Nikonos has an interchangeable lens (28mm, f/3.5) that is made for underwater use only. It cannot be used in the air (above the surface of the water). It is known as the UW Nikkor. The standard lens that comes on the Nikonos is a 35mm, f/2.5.

Figure 14-1 shows the controls and some of the special features of the Nikonos camera. By studying the photography of the camera it can be seen that the controls were made for ease of operation under adverse conditions. Most notable of the controls is the shutter release lever which also advances the film and cocks the shutter with a single stroke of the lever. Another

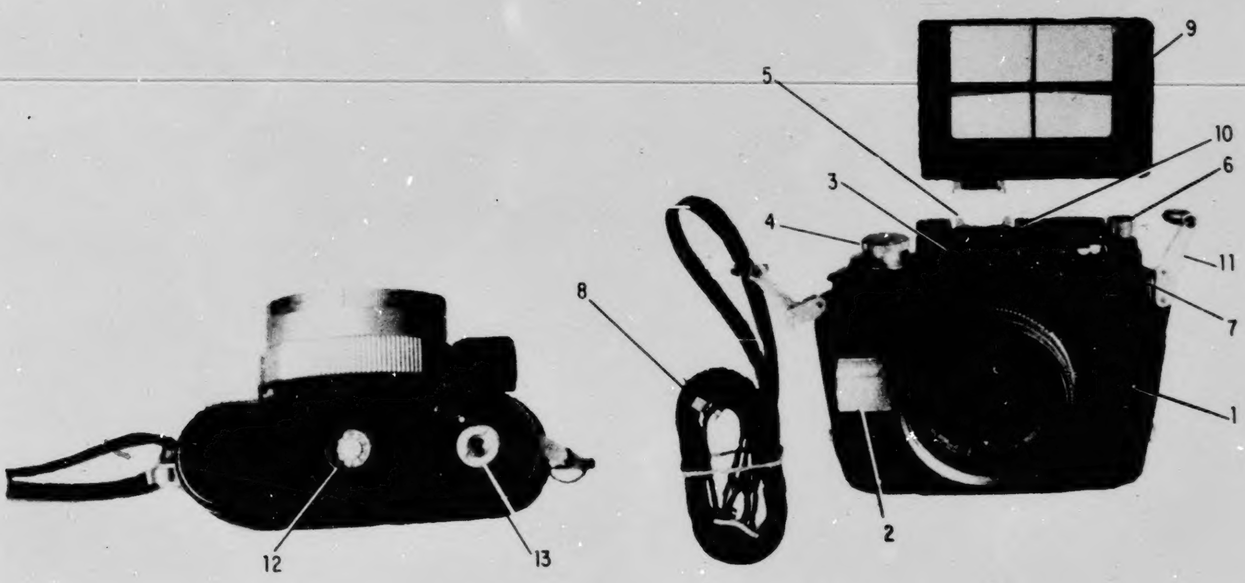


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Figure 14-1.—Nikonos underwater camera.

notable feature is the manner in which the focus and aperture are adjusted, one large knob on either side of the lens. Figure 14-1 shows these knobs fitted with accessory rubber grips. The rubber grips make adjustments easier when wearing gloves or working under water. Note that one knob is black (focus) and the other is white (aperture). This is to coincide with the background color of the focus and aperture scales. The Nikonos lens can be installed upside down to facilitate easier reading of focus and aperture scales when looking over the top of the camera.

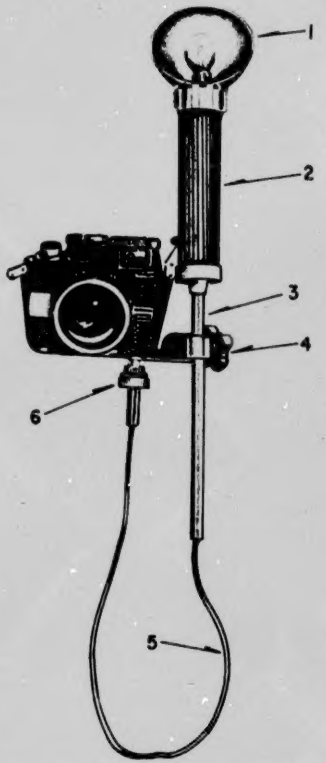
The underwater viewfinder is designed for use where the photographer is wearing goggles or facemask, making it impossible to view through the optical viewfinder. It is used in the same manner as an aerial viewfinder. Most photographers refer to this type of finder as a sports viewfinder.

Other accessories that are necessary items in underwater work are an exposure meter designed or calibrated for the purpose, and a suitable light source. The exposure meter will be covered later in this chapter.

Nikonos cameras have a specially designed flash unit for use under water. Its parabolic reflector is tilted back at an angle to compensate for the refraction of the light rays through the water. (See fig. 14-2.) The unit synchronizes at all speeds except B and 1/30 sec. using FP type flash bulbs (Sylvania FP 26 or G.E. No. 6).

There are several methods of carrying flash bulbs underwater. One method is to take a sheet of thin rubber, such as a part of an innertube, about 3 x 12 inches long. Cut small crosses in the rubber and push the base of the flashbulbs through these cuts. A strip of rubber this size should accommodate approximately 15 bulbs. The strip with the flash bulbs can be attached to the diver or to his equipment by means of a lanyard to prevent their floating away while submerged.

Only a brief description can be given in this chapter on the Nikonos, but the general characteristics desired in any camera for use under water have been covered and some of the reasons for these desired features are explained in the following paragraphs.



PH.560
Figure 14-2.—Flash unit for underwater photography.

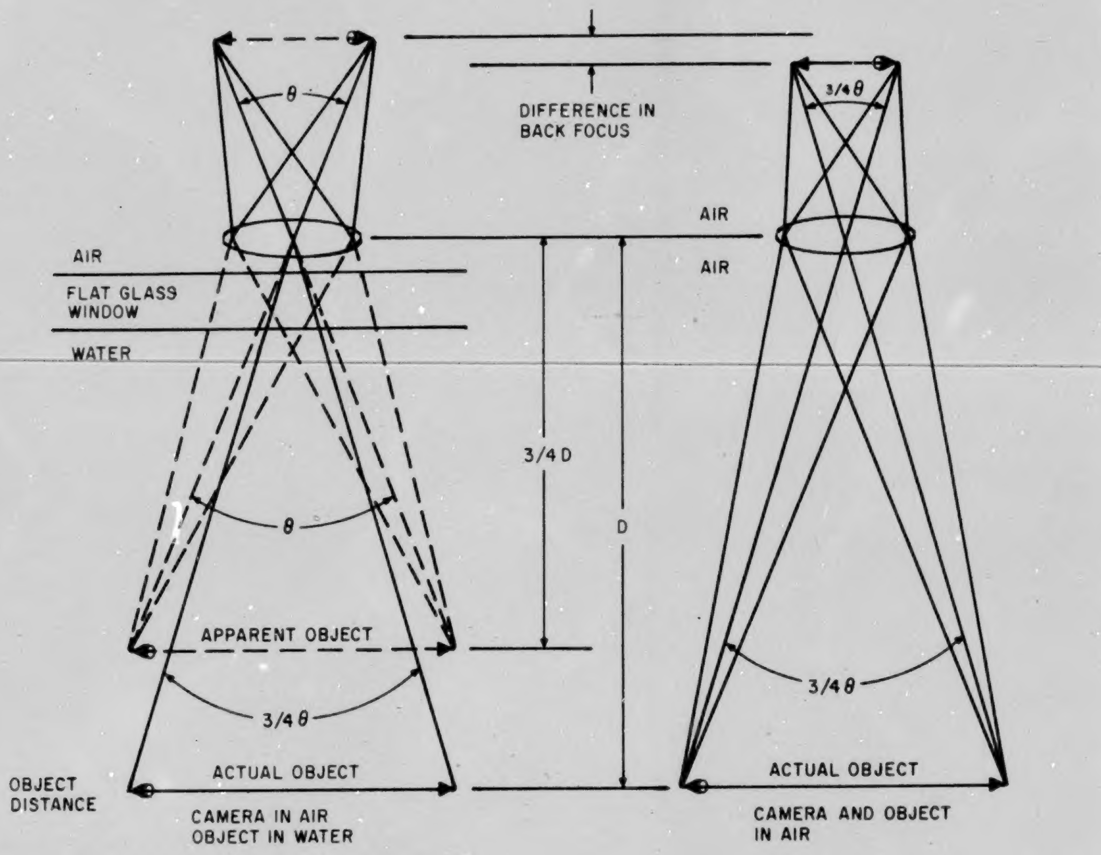
As a general rule, the lens of the camera should be of the wide angle type for underwater use, in order to photograph a given area through a short water path. A wide angle lens provides more depth of field than a normal angle lens, when both are used at the same distance with a given camera. If you move in with the wide angle lens to obtain the same size image as that of the normal angle lens from the greater distance, depth of field will be exactly the same for both (assuming the same f/stop is used). It is object distance and f/stop that controls depth of field.

Due to the refraction of light by water, objects under water appear closer by 1/4 of the object-to-camera distance. (See fig. 14-3.) Consequently, focusing scales for cameras intended for use in air can only be used if the underwater object distance is related to a distance in the air. This distance is 3/4 of the underwater camera-to-object distance, provided the camera port is a flat plane and the distance from the front nodal point of the lens to the glass-water surface of the housing is small in comparison with the distance from the glass-water surface to the object. If the actual object distance is not known you can, when under water, focus to the apparent object distance (as you see the subject) without attempting to compensate for refraction. This procedure is effective because the refraction of the water affects the eye and camera lens to the same degree.

It is advisable to have the smallest possible amount of water volume between the camera and the subject, since even very clear water may distort the light to such an extent that a short distance may make the difference between a good or bad underwater photograph. A wide angle lens permits the photographer to get closer to the subject than a normal angle lens.

Most underwater cameras now in use by the Navy have external controls for focusing, adjusting f/stops and shutter speeds, and tripping the shutter. In addition, some underwater camera housings have built-in exposure meters which permit the determination of approximate underwater exposures.

Ideal cameras for motion picture use are driven electrically with a battery pack. They must have a large film capacity—400-foot maga-



θ
DIFFERENCE IN BACK FOCUS
3/4 θ
AIR
AIR
AIR
FLAT GLASS WINDOW
WATER
3/4 D
D
θ
APPARENT OBJECT
3/4 θ
3/4 θ
ACTUAL OBJECT
ACTUAL OBJECT
OBJECT DISTANCE
CAMERA IN AIR OBJECT IN WATER
CAMERA AND OBJECT IN AIR

PH.561

Figure 14-3.—Effect of water in the object field on camera focusing.

zines being preferable. The exception to the above is the Sampson Hall 16mm which is spring wound externally and only has a 100-foot film capacity. This camera is used mostly for cuts and closeups. It is easily controlled because of its size.

With the large variety of underwater cameras available, self-made housings should be attempted only as a last resort. Plexiglas is the easiest material to use. Caution must be taken when installing external controls. THEY MUST BE PRESSURE PROOF. Safety glass can be used for the photo port.

UNDERWATER EXPOSURE–NATURAL LIGHT

The undersea photographer works in a complex and changeable medium under difficult conditions of cold, violent swaying of both the photographer and the equipment; and the encumbrance of diving equipment. There are various conditions which arise in underwater photography which are not present on the surface, making the calculation of exposure difficult.

Underwater photography by natural light should be undertaken between midmorning and midafternoon. The best lighting conditions prevail from 0900 until 1400, since the amount of light available under water decreases as the sun gets lower in the sky. Illumination intensity underwater also depends upon reflection from local objects; for example, the light level is greater over a sandy ocean bottom than it is over seaweed.

Light Absorption By Water

Water has the effect of rapid absorption of light, as the light penetrates to greater depths beneath the surface. The first foot of water may remove up to 58 percent of the infrared portion of the spectrum but very little of the visible portion. This loss is dependent on the type of water encountered. In pure sea water, 56 percent of the surface visible light intensity remains 25 feet down, while in turbid or muddy water (depending on the degree of turbidity or muddiness), the light is proportionately decreased as depth is increased.

Not only the depth at which the photographer is working will change the intensity of the light, but also the distance from which he is photographing the object. Remembering that turbid or muddy water affects the amount of light reaching a subject, these same conditions also affect the amount of light reflected from the subject to the camera. Thus, camera to subject distance must be taken into consideration on all exposures.

Light Scattering

When a beam of light in the air or under water falls on a very small particle, such as dust, the particle can be expected to absorb some light and reflect the remainder.

Multiple reflections from many particles produce scatter or haze which sets a practical limit on the visual or photographic underwater range. Normally, with the proper lighting equipment, unless absorption is particularly great, there is sufficient light for photography in waters reached by diving equipment. The maximum distance at which an object may be clearly defined depends on the amount of light which is scattered by the intervening substances (microscopic plant life and animal life, sand, etc.) in the water and the scattering effect of water itself. That part of the scattered light which the observer sees coming from the direction of the object appears as an overall haze and lowers the apparent contrast between the object and the surroundings. As the distance to the object is increased, the object fades more and more into the haze and is eventually lost to view except for bright highlights. In true oceanic waters (offshore), the transparency of the water is very high and the scattering is slight.

In even the clearest coastal water, the scattering is a result of suspended matter of all sizes in the water. Both absorption and scattering can give rise to color effects in bodies of water. Filters may help to provide color correction or contrast, but they offer little in minimizing the effects of turbidity or scatter.

Sea waters are normally clearest during the cold months when microscopic plant life and animal life in the water are at a minimum.

Exposure Meters

The best method in calculating underwater exposure is with an exposure meter—an absolute essential in underwater photography.

The mere loss of gross intensity due to absorption and scattering is not the only factor to be considered in calculating exposure, for light of different color is absorbed at different depths in sea water. For example, at only 3 or 4 feet below the surface, red light is almost completely absorbed. Orange light fades out at approximately 30 feet. Yellow and violet light starts being absorbed at about 33 feet, until only blue and green light remain at 65 feet.

Most light meters read light intensity without regard to color balance. Because the spectral character of light under water will be different from that on the surface, taking exposure meter readings and calculating filter factors can be a problem. The problem of determining filter factors, shutter settings and aperture settings, is compounded beneath the surface of the water. Factors other than light characteristics are encountered by the photographer from the moment he enters the water. His stability and mental capacities are impaired by the unnatural environment, and the impairment becomes more acute the deeper he descends.

Under water there may be only blue-green light, an abnormal color mixture for a meter calibrated for average daylight. For full panchromatic film, the reading under such conditions may be all right, provided the meter is designed to read all visible light with roughly the same response as the film.

It is well to remember that errors can occur in light meter readings due to the abnormal spectral distribution undersea; therefore, if possible, the best method is to make a series of test exposures shot at a range of f/stops around the meter reading. Experience with the meter should soon show how its readings are to be corrected for normal underwater photography in the vicinity.

Model L-164 Marine Exposure Meter

The Model L-164 Marine Meter is especially designed for underwater photography though it is equally good for use as a regular exposure meter on land. It is capable of a maximum depth of 325 feet.

DESCRIPTION.—The meter is 3.3 inches in diameter and 2.7 inches in height and weighs approximately 9.3 ounces on land and about 2.1 ounces in the water. The case is bright orange so it can be easily spotted if lost while swimming.

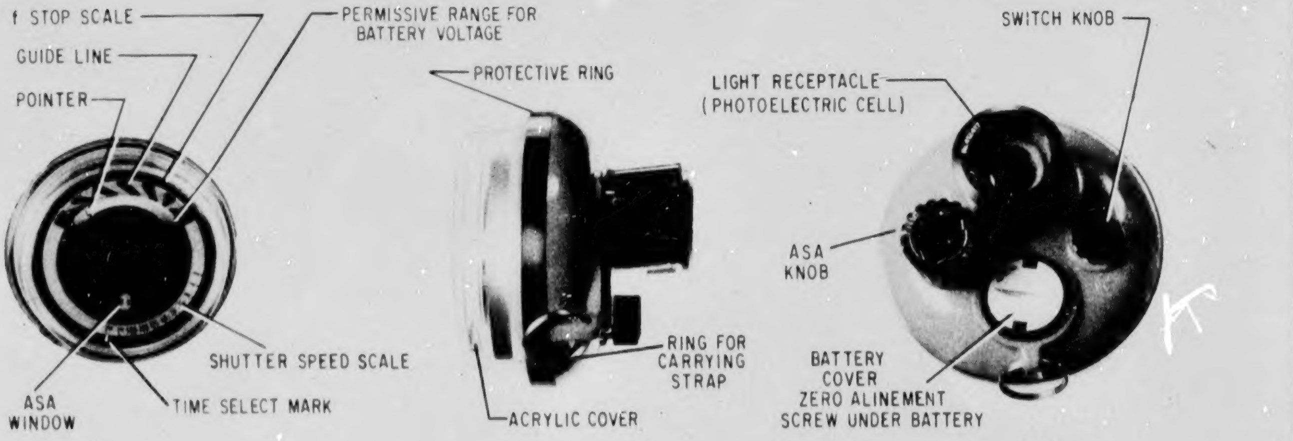
The meter can be attached to the belt or diving harness by the "snake chain" that comes with it, or by use of a retractable key pull.

The meter can withstand a temperature range of −50° to +113°F. It is a single CdS meter with power supplied by a 1.3V mercury battery. The ASA scale has a range of 6.0 through 12,000 and the shutter scale runs from 1/2 second to 1/2000 second. The range on the f/stop scale is 1.0 up to 45. For a better understanding of the design and working parts of this meter, study figure 14-4.

Filters

The diffused light conditions caused by scattering reduce the color contrast and blur the edges of objects viewed at a distance. This blurring or haze obtained in distant photographs in clear water is caused primarily by scattering of the blue light. One method used in black-and-white photography to reduce the blur haze and gain contrast is by using a blue elimination filter, such as a Wratten K or G. However, the filter considerably reduces the amount of illumination reaching the film. Another method of increasing the contrast is by overdeveloping the negative.

Because of the difference in color balance under water from that on the surface, the figuring of filter factors is somewhat complicated. The published filter factor for a specific filter is generally not the one which must be used when the filter is used under water. For example, a Wratten G filter, which transmits in the red-yellow region and has a filter factor of 2 in white light, would give a grossly underexposed negative. The meter is reading gross light intensity, most of which will be in the blue region, which the G filter does not transmit. The actual filter factor might be as high as 10. The only suitable way to arrive at an exposure with such a blue-green blocking filter is to procure a square of filter material and take a light meter


f STOP SCALE
GUIDE LINE
POINTER
PERMISSIVE RANGE FOR BATTERY VOLTAGE
PROTECTIVE RING
SHUTTER SPEED SCALE
ASA WINDOW
TIME SELECT MARK
RING FOR CARRYING STRAP
ACRYLIC COVER
SWITCH KNOB
LIGHT RECEPTACLE (PHOTOELECTRIC CELL)
ASA KNOB
BATTERY COVER
ZERO ALINEMENT SCREW UNDER BATTERY

PH.562

Figure 14-4.—Model L-164 underwater exposure meter—Sekonic Marine.

reading with the filter material over the lens of the meter.

Black-and-White Film

Any type of fast panchromatic, long scale film may be used in underwater photography, depending upon the light condition.

Color Film

Fast daylight type color film, either negative or positive, may be used for underwater photography. As explained earlier, due to the filtering action of the water, the predominant light under water is blue-green. This predominance of blue-green light is less noticeable to the underwater photographer, whose eyes automatically adjust to the prevailing light conditions, than it is to color film which is balanced for light of a certain color temperature. The use of red color correction filters is of doubtful value since they can only be used where red and orange light have not completely disappeared from the water. In addition, the use of a filter calls for a larger lens opening which decreases the depth of field. Use blue bulbs for a distance of less than 3 feet with daylight color films. Use white (clear) bulbs from 3 feet to 10 feet. If flashbulbs are used beyond 10 feet, there is usually too much absorption in the water to be effective and color balance of the photograph is off.

UNDERWATER EXPOSURE—ARTIFICIAL LIGHT

The use of artificial light, such as photoflood bulbs, flashbulbs, or electronic flash, is very helpful in providing sufficient illumination and color balance in underwater photography.

By the use of artificial light, the underwater photographer has two additional controls over picture quality: (1) the ability to place the light source at any desired position, and (2) the ability to select, within limits, the spectral character of the light.

When using flashbulbs under water, the following advice is applicable:

1. No special type of bulb is required for depths of approximately 20 feet. Flashbulbs may be carried to an underwater depth of approximately 200 feet before they will burst.
2. Inspect each bulb for cracks prior to use; discard if defective.
3. Rub the base of each bulb on sandpaper to insure better contact.

Black-and-White Flash

A new problem is involved in using flashbulbs under water. Flashbulb guide numbers are intended for use in air and must be modified to compensate for the light absorbed by the water path from lamp to subject and subject to camera. For example, 1/2 of the light energy is absorbed by the water when going to the subject and 1/2 of the remaining light is absorbed when returning to the camera; thus, only 1/4 of the original light energy reaches the camera to expose the film. To determine the modified guide number multiply the published guide number by the square root of the change desired as shown in the following example:

Guide Number Change Desired X	Published Guide Number	$\sqrt{x}$	Modified Guide Number
1/4 (0.25)	150	0.5	75
1/6 (0.16)	150	0.4	60
1/8 (0.125)	150	0.36 appx.	54
1/16 (0.0625)	150	0.25	37.5
1/25 (0.04)	150	0.2	30

An alternate approach is to apply the correction in terms of f/stops; e.g., determine the suggested f/stop and apply the exposure increase required by opening up the lens aperture. For example, if an 8 times increase in exposure is required and the published guide number indicates an opening of f/11, increase the lens aperture three whole stops from f/11 to f/4.

The photographer should, when first starting off with new equipment or photographing in a new vicinity, take three pictures of the subject—one at the calculated exposures, one two stops open, and one two stops closed. Since most black-and-white film has enough latitude for a one stop error, a satisfactory photograph should result.

The following steps are suggested for calculating a flash exposure under water:

1. Select bulb type, film, and shutter speed to be used; then ascertain the guide number for that combination.
2. Estimate water transparency either from experience or in the following manner: Take an exposure meter reading on the back of your hand under water. Take other readings at various depths farther down; i.e., 5, 10, and 15 feet. By comparing the readings, estimate the number of stops needed to get proper exposure at these depths; for example, a one stop opening might be needed at a 10-foot depth.
3. Estimate the light path length (twice the distance to the object being photographed). Using the published guide number, obtain the basic f/stop to be used.
4. Apply the transparency correction arrived at in step 2. For blue-dipped bulbs this will be close to the correct value.
5. Make test exposures and keep track of each one. Correct the above procedure for the water you are in, by studying the results of the test exposures.

Scattering may be even more troublesome with flash than with natural light. The beam of light transversing the water between the subject and camera may sharply illuminate scattering centers. A partial solution is to move the light source close to and off to one side of the subject. This will also cut down the total light path length, allowing use of a smaller f/stop.

6. Once the new guide numbers are determined, seal them in plastic and attach to the flashgun or wrist for ready reference underwater.

Color Flash

When using color film under water, especially in depths over 20 feet, improved color balance can be obtained by the use of flashbulbs. When the flash is the major light contributor, clear flashbulbs are the best source, as their reddish illumination will compensate for the higher absorption of red and yellow by water. Blue flashbulbs will not provide as much light as clear flashbulbs, but the color balance can be helpful at short object distances where red absorption is slight. At large distances, the blue filter material (on flashbulb) can make the blue-green cast of the water more apparent.

The calculation for exposure can be made in the same way as outlined in the section on black-and-white flash (remember that color exposure is more critical, and that the calculations will be more exacting).

Fill-In Flash

In clear shallow water it is often desirable to use flash as a fill-in with natural light. This added light will fill in the foreground and brighten up the object being photographed, making a much more pleasing photograph. Fill-in flash should always be used with color, as it will give much better results than natural light alone.

Since the path lengths for flash and sunlight in water 10 feet or so deep are roughly the same, the flashbulb to use is the clear type. In this way the color balance from the surface light and the flashbulb will be about equal at the camera. If this is not done, unpredictable colors might result.

DEVELOPMENT

In the developing of underwater photography, normal or fine-grain developers should be used, forcing the development somewhat so that adequate contrast is obtained. Because of the structure of the water and the particles suspended in it, rapid, high-contrast developers should not be used as they will tend to make the negative appear grainier than it actually is.

Printing should be done on a somewhat contrasty paper, so as to give a good snappy appearance to the finished product.

CARE OF EQUIPMENT

1. After use, wash all camera housings, flash units, tripods, etc., with fresh water and a mild soap. Rinse well with fresh water.
2. Disconnect all flashgun connections and clean. Use emery cloth on contacts to insure clean connections for the next use.
3. Check all batteries, discard if weak, and check the flash unit for a salt water ground or leakage path. Salt water grounding of the flash unit places additional drain on the batteries, and reduces battery voltage and capacity.
4. Check all seals and lubricate with a silicone or O-ring grease.
5. Use a defogging agent on the inside of the glass port or plastic housing. This will aid in preventing fogging because of temperature changes.

UNDERWATER SAFETY PRECAUTIONS

The Navy's highly skilled underwater photographers are also thoroughly versed in safety precautions pertaining to their work in and under the water. It is recommended for reasons of personal safety that the neophyte underwater photographer (skin diver) undergo a full course of instructions with an organized training class, in underwater diving apparatus and safety before attempting any underwater work of any type.

While it is not within the scope of this rate training manual to cover in full detail all aspects of safety in underwater photography, a general discussion of fundamental safety will be covered in this section.

Physical Condition

In order that they may successfully accomplish their frequently strenuous missions, the Navy's underwater photographers must be in excellent physical condition at all times. Individuals having bad hearts, weak lungs, or sinus trouble should not engage in underwater photography as serious physical damage may result.

Inherent Dangers of Diving

The underwater photographer must always remember that there are certain elements of danger, especially when the iron clad rules of diving are violated.

As the diver acquires the ability to remain underwater at greater depths for longer periods of time, strict adherence to diving tables (tables indicating the time of descent and return to the surface from given depths) becomes increasingly important. If strict adherence to these tables is not followed, bends (aeroembolism) and/or depth intoxication (nitrogen narcosis) will likely result.

Air embolism is probably the main danger in scuba diving. Air embolism is caused by the diver holding his breath (failing to exhale) while ascending from a deep dive. This often occurs whenever the scuba diver has had an interruption in his air supply or for some other reason has become panic stricken and attempts to make a rapid ascent to the surface while holding his breath.

Other dangers include anoxia. Anoxia can come about with little warning and result in unconsciousness in extreme cases. It is caused by insufficient oxygen in the breathing mixture. Pure oxygen under pressure should not be used in the breathing mixture as it can damage nerve centers and blood vessels. Too high a percentage of oxygen in the breathing mixture is also toxic. The tolerance of oxygen percentage in the breathing mixture will greatly vary between individuals. Oil free compressed air should be the only breathing mixture used in scuba diving.

Excessive carbon dioxide in the breathing mixture is also a danger. A canister of absorbent material is designed to remove this exhaled gas (carbon dioxide) as rapidly as it is exhaled. However, if the canister is defective the gas can rapidly build up. As the carbon dioxide level rises, the efficiency of the canister is reduced even more. When the carbon dioxide level rises above 3 percent there will be definite discomfort. After the level of carbon dioxide in the breathing mixture has risen over 10 percent unconsciousness may result.

Equipment

It is imperative that all diving equipment be carefully and properly maintained. Even though it may be sold at a bargain price, unbranded and/or rebuilt equipment should be avoided. Use only approved factory guaranteed brands, especially where the breathing apparatus is concerned.

Other useful and often indispensable accessories that can be considered items of safety equipment are: a good depth gage, compass, watertight watch, hunting knife, underwater flashlight, snorkel, mask, fins, and frequently gloves and a wet suit.

All items should be easy to dispose of in cases of an emergency. However, the snorkel mask, and fins should be retained.

One of the most important safety factors to remember is the underwater photographer (scuba diver) must never assume the part of a lone wolf, while in the water. He should be in visual contact at all times with one or more other divers. It is also highly desirable that some type of contact be maintained with personnel on the surface.

Underwater photography is quite safe as long as the potential dangers are not overlooked, the diver is in good physical condition, and all diving equipment and accessories are properly prepared and maintained.

REPAIR, INSPECTION, AND TESTING OF PHOTOGRAPHIC LABORATORY AND FIELD EQUIPMENT

Equipment maintenance and repair are of utmost importance in the operation of a photographic laboratory. As set forth in Chapter 1, U.S. Navy Manual of Naval Photography, OpNav 3150.6 (Series), it is the responsibility of the photographic officer to insure that photographic facilities and equipment in his charge are maintained "in approved operating condition." The senior petty officers must exercise every effort to insure that all personnel are familiar with the operation and general maintenance of equipment on hand. In view of the fact that nearly all equipments used in photography are precision type items, improper careless or rough handling can lead to serious damage. This is especially true with some of the more sophisticated electronically operated and controlled equipment in use in photography today.

Every photographic laboratory has on file (or should have) publications which detail the construction, operation, and maintenance of all equipment on hand. Frequent reference to these publications and strict adherence to a positive, preventive maintenance program is necessary to insure that the equipment will perform efficiently. These publications include the Cumulative Edition of Photography Technical Bulletins, NavWeps 10-IR-500A; U.S. Navy Photography Technical Bulletins, NavWeps 10-1TB-(Series); and various other maintenance instructions manuals and manufacturer s operation instruction manuals.

Qualified petty officers should hold training classes in this phase of laboratory procedure, making certain that personnel are thoroughly indoctrinated in the correct use of all the equipment, maintenance and operating instructions, and preventive maintenance.

The repair of photographic equipment is usually the task of qualified photographic repair personnel who are graduates of the Class C Camera Repair School at Pensacola, Florida.

NEW EQUIPMENT

The U.S. Navy Photography Technical Bulletins, published under the direction of the Commander, Naval Air Systems Command, are primarily for the information and education of all personnel directly concerned with naval photography. From time to time modifications to various items of photographic equipment are published in these technical bulletins. In many cases the bases for these modifications come from fleet and shore laboratories which receive and place new equipment in operation. Although manufacturers test and check equipment before it leaves the factory, minor defects and operational problems may appear when the equipment is placed in operation.

Upon receipt of new equipment, the operation and service instruction manual must be carefully studied and the equipment carefully tested by competent personnel. After all components of the equipment are checked, the equipment should be test operated for a period of time in order to insure proper operation. Operational discrepancies should be noted and evaluated. Minor discrepancies should be corrected locally if possible.

DEFECTIVE EQUIPMENT

One of the duties of the senior Photographer's Mate is to screen defective photographic equipment to determine the feasibility of local repair in lieu of exchange.

Local Repair

Any photographic repairs may be undertaken that are within the capabilities of assigned personnel and spare parts available in the supply system. Fleet Air Photographic Laboratories are authorized to perform emergency "over-the-counter" repair of photographic equipment for local area photographic laboratories not having a repair capability. Applicable instructions are issued by the Aviation Supply Officer and the Commander, Naval Air Systems Command, with respect to the turning-in, repair, and issue of repairable items.

The repair of nonstandard photographic equipment is the responsibility of the holding activity. When major repairs are beyond the capabilities of the personnel assigned, commercial repair services may be obtained by established contractual procedures.

Exchange

A repairable item will be turned in, complete with component parts and accessories, or accompanied with proper survey papers covering the missing items, to the designated repair point. The material will be turned in on a Release/Receipt Document (DD Form 1148-1). A replacement item then may be requisitioned on a reimbursable basis under the Navy Stock Fund from the designated supply point. The requisition submitted to the supply point for the replacement will bear a statement similar to the following:

> "Required as replacement for like item in repairable condition shipped to (designated repair point) on memorandum invoice number________ dated __________."

The invoice which accompanies the repairable item to the repair point will indicate that a replacement has been requisitioned by inclusion of a statement similar to the following:

> "Replacement requisitioned from (designated supply point) on requisition number __________ dated __________."

Upon receipt at the repair or overhaul point, the returned item is screened.

If a replacement is desired for an item of equipment which is performing limited useful service and it is necessary to retain the old item until receipt of the new, the requiring activity will attach to the requisition a statement similar to the following:

> "Required as a replacement for a like item in need of repair. Repairable item, complete with component parts and accessories, or accompanied with proper survey papers covering missing parts, will be forwarded to (designated repair point) upon receipt of ready-for-issue item."

INSPECTING EQUIPMENT

The best guarantees for trouble free operation of all photographic equipment are inspections and preventive maintenance. The proper inspection of cameras and laboratory equipment is a must since it insures that the equipment will be in a serviceable condition, as nearly as possible, at all times.

Regular periodic inspections should be held on all lab equipment, including washers. Regular inspections, replacing worn parts, and repairing malfunctions will prolong the life of the washer and keep it operating for an indefinite period.

Inspection procedures are set forth in most manufacturer s equipment manuals and/or various technical bulletins. These instructions give procedures for specified interval inspections and frequently for preuse inspections.

In the event that preuse inspection is not included in either the manufacturer's equipment manual or technical bulletins you would be wise to set up your own written procedure. Naturally the more complex the equipment the more complex the inspection checklist.

You must use your own ingenuity to assure that both the interval and preuse inspections thoroughly cover the equipment. If it is found by experience that additionai items need to be inspected, add them to the inspection list already established, but never delete any items from the already established instructions without careful consideration.

Instructions given in equipment manuals and technical bulletins for inspections are considered the minimum number of items for inspection, not the maximum.

TESTING PROCEDURES

Any piece of photographic equipment, especially if it involves just one single chance at getting the final product, should be tested prior to use.

Items falling in this class include cameras, flash equipment, rangefinders, shutters, viewfinders, processing equipment, and aircraft camera control systems.

In the course of a single year, any individual piece of photographic equipment may be exposed to rain, snow, cold, heat, wind, dust, dirt, and extreme dryness or humidity, in addition to damage from salt spray. This exposure to the elements takes its toll. Mildew can develop, dust can get into mechanical parts, lens elements can become separated, carrying straps wear out, electrical contacts corrode, and metal parts rust or corrode.

It is only by diligent care and the use of preventative maintenance that this deterioration can be held to a minimum. Many malfunctions occur, and equipment is ruined, from neglect of preventive maintenance, failure to inspect and test the equipment, and a lack of knowledge on the part of the person handling the equipment, which includes failure to read and understand the instruction manual(s) before attempting to operate the equipment.

Visual testing or inspection of nonmechanical items such as lenses, bellows, flash lamps, cords, cables, and film holders or cassettes will normally give a good indication of their condition and usability. This visual check should be a thorough observation of the condition of the item, not a simple cursory glance. Examine the equipment with the thought in mind that something may be wrong. Then prove to yourself that all parts are in a satisfactory condition. It is amazing how many flaws and/or potential trouble sources can be found and corrected by looking for them in advance. Sometimes it is the simplest and most obvious things that will give trouble. So visual testing or inspecting may save you from considerable embarrassment.

Operational Testing

Each functional item of photographic equipment should be required to prove itself. This applies to both field and lab equipment. Any item that must function to contribute to the final product must be considered a possible danger spot.

There is often a tendency to let seldom used items slip by in both the visual and operational tests. Do not be led into a sense of false security just because an item of equipment is seldom used. Check each item that will be needed or might be needed well in advance of the assignment.

Pay particular attention to items which tend to deteriorate slowly. A bellows with reasonable care lasts a long time but sooner or later it will break down at the folds, especially in the corners, and all it takes is a small pinhole in a bellows to spoil a photograph.

Flash batteries lose their power slowly under normal operating conditions, but just because the amperage output yesterday was sufficient to complete an assignment is no indication that the batteries will perform satisfactorily today. It is best to use an ammeter for checking the flash batteries before an assignment.

The effectiveness of operational testing depends upon the equipment being checked in a manner simulating actual operation. Prior to going out on an assignment some of the functional items that should be tested are shutters, rangefinders and focusing mechanisms, diaphragms, viewfinders, exposure meters, flash equipment, film advance mechanism, and batteries.

The certainty of having a useable negative is still not established after the exposure has been made. Suppose the timer in the darkroom ceased to function while the film was in the developer, and there was no other method available to determine how much time has elapsed. Could you accurately decide when to remove the film from the solution? You might, but you could also ruin the negatives. A little thing like testing electronic interval and/or mechanical timers may mean the difference between success and failure.

Is it worth the time and effort for all of this testing and inspecting? To answer this question, let us look at the alternative. How would you as a senior photographer like explaining to the Photographic Officer, Department Head, and possibly the Executive Officer and Commanding Officer why the picture or pictures that were requested (especially if they cannot be retaken) failed to turn out.

MAINTENANCE

Anything that will assist in keeping the equipment working properly might be called maintenance. Maintenance procedures vary from the simplest preventive measures to depot level maintenance. This Rate Training Manual will be limited to preventive and minor maintenance.

Any corrective action taken on electronic interval timers, camera shutters, camera control systems and other delicate and/or complicated equipment should be performed by competent photographic repair personnel only. The novice should not attempt repairs to this equipment, for he may make the existing damage worse or even cause additional damage.

In addition to the inspection of the equipment a preventive maintenance and service schedule with competent supervision should be set up for each piece of laboratory and field equipment. The Maintenance Instruction Manuals for each piece should be checked and a service and lubrication schedule initiated. The system should be strictly adhered to, once it has been set up.

Preventive maintenance can be described as those minor maintenance procedures that are performed to prevent wear or other damage to equipment. Some preventive maintenance is up to the individual and his commonsense. This includes such things as tightening loose screws, repairing a loose wire, covering an exposed electrical conductor, cleaning rust and corrosion from metal and electrical contacts, and other minor things that can be easily and efficiently corrected. In the following sections, three types of preventive maintenance—adjustments, cleaning, and lubrication—will be presented.

Adjustments

If top quality results are to be constantly produced, properly adjusted equipment is necessary.

Maladjustment can result in ultimate damage to the equipment and/or the waste of costly sensitized material in addition to the failure of an assignment or mission. Manufacturer's Manuals and Technical Bulletins/Manuals contain the procedures for making such adjustments as may be necessary. When adjustments are made, insure that established procedures given in these publications are followed.

Cleaning

Cleaning is mainly a matter of controlling airborne foreign matter which accumulates from day to day. If a solvent other than water is necessary, make sure that it is authorized. Operational and maintenance instructions for the equipment will specify the solvent, the strength, and the procedure to be used in its handling and application.

In most between the lens type shutters, faults can be traced to dust, dirt, sand and other foreign matter that has found its way into the shutter mechansim. Foreign matter can slow down shutter speeds.

Scratched negatives are often caused by the camera's film pressure plate being dirty, scratched, having burrs or in some manner not being perfectly smooth, or by the film cassettes having foreign matter such as dust and grit on the light trap through which the film passes.

If film is kept rolled after processing, rolling and unrolling it when the negatives are to be viewed and/or printed can result in scratches. Immediately after processing, and when it is perfectly dry the film should be cut up and placed inside suitable negative preservers.

Photographic lenses should never be cleaned with chemicals and lens paper designed for the cleaning of eye glasses. These cleaning materials contain abrasives and/or chemicals that can remove the lens coating and scratch the lens.

Before a roll of film is placed inside a camera the inside of the camera should be inspected and cleaned of any dirt, dust, film particles, or other foreign matter.

BATTERY CONTACTS.–Many cameras, exposure meters and other related equipment require batteries for their operational functions. These batteries, even the so called long life types, can be a source of problems. Batteries should be tested for sufficient voltage/amperage either in the equipment, if it contains a built in tester, or with the aid of a battery tester or ammeter each time the equipment is to be used.

A not uncommon source of malfunction is batteries being inserted improperly. In this situation one or more batteries are reversed from their proper position. Insure that all batteries are placed in the equipment according to the manufacturer's instructions and the directions usually found in the battery compartment of the equipment.

Keep the electrical contacts on both the equipment and batteries clean. Deposits often invisible to the eye can build up on the electrical contacts of both batteries and equipment during shipment and storage. This deposit prevents sufficient electrical contact between the batteries and the equipment and must be removed by proper cleaning. These contacts can be cleaned by rubbing them with a rough cloth or, if the contacts are recessed, a pencil eraser.

Do not clean the electrical contacts on photographic equipment with anything rough like sandpaper, emery cloth, orange sticks, or files. Rough items such as these will remove the plating on the contacts.

Keep your hands clean and dry when inserting batteries. Oil from the skin acts as an insulator and creates a barrier between the equipment and battery contacts. The batteries used must be of the designated type and voltage specified by the equipment manufacturer.

MIRRORS.–Mirrors used in single lens and twin lens reflex type cameras are of the front surfaced type. This type of mirror is composed of metal and alloys, generally aluminum, deposited on a glass support by vacuum evaporation. This metallic surface coating is very susceptible to damage if cleaned improperly. Rubbing a front surfaced mirror with lens tissue or any other cleaning materials, particularly a pocket handkerchief, to remove dust and smudges can cause scratches and remove the surface coating of the mirror. Small amounts of dust and slight smudges on the mirror surface, although frequently annoying, have no effect on the image forming capability of the camera lens. No attempts should be made to clean these mirrors, except to remove surface dust by blowing a gentle stream of air across the mirror surface with a syringe type blower.

PRINT WASHER.–The photographic print washer is an item which requires frequent cleaning. After each 3 days in use the drum should be lifted from the tank for a thorough cleaning. Lift the drum straight up and out of the tank, flush the tank out thoroughly with clean water, lower the drum back into the tank, and repeat the process.

Once a week, wash the drum and the inside of the tank with a clean cloth saturated with a soap solution. Wipe off all chemical deposits and then flush completely with clean water. Where heavy chemical, iron, rust, or other deposits of impurities have collected, special solutions must be used to properly clean the washer. A 10 percent solution of sodium nitrate sprinkled with whiting compound may be used as a cleaner. On unpainted stainless steel surfaces, a 2 to 5 percent solution of oxalic acid should be used. Never use a wire brush or steel wool to clean a washer and do not use the oxalic acid solution on painted surfaces.

Lubricate the washer, as specified in the Operation and Service Manual (TO 10-25F-9) each month or after 200 hours of operation. Do not lubricate anything that fits or goes into the washer tank.

STAINLESS STEEL TANKS AND TRAYS.—Photographic tanks and trays, made of stainless steel, if carelessly used, can become badly damaged and corroded. With careful cleaning and maintenance, stainless steel will last many years.

The corrosion resistant qualities of stainless steel are achieved by the alloy used in the stainless steel, and by a special treatment called "passivation." Passivation develops a thin surface film of oxide that protects the stainless steel surface from corrosion, and also removes such corrodible materials as iron particles and other contaminants that may exist in the surface of the alloy.

The corrosion resistant film can be impaired, however, if the stainless steel equipment is kept in contact for any length of time with iron or its compounds, or with bleaches like those used in color processing which contain potassium ferricyanide. Avoid using ordinary steel wool, grit cleaners, and grit papers which will abrade the surface and cause corrosion.

Meticulous care and cleanliness will retain the impervious qualities of stainless steel. Wipe down daily all stainless steel equipment in use with a wet cloth. Thoroughly scrub and wash weekly with a nongrit soap or cleaner of the mildest possible type.

Whenever detrimental compounds contact the surface of the stainless steel, take immediate action to wash them away thoroughly. Then drain and dry the equipment. The tops of film hangers, although not in the solution when in use, may become splashed by chemicals and should always be thoroughly washed and cleaned.

Whenever the protective oxide film becomes damaged by corrosion, it must be restored by repassivation. The procedure for repassivation of stainless steel is contained in U.S. Navy Photography Technical Bulletin, NavWeps 10-1TB-23.

For long term storage of stainless steel equipment, rub a good quality oil or grease over all surfaces before storing. During such storage, regularly inspect the equipment in order to detect any signs of corrosion or deterioration.

GLOSSY PRINT DRYER.—The drum of a glossy print dryer must be very carefully protected at all times. It has a highly polished surface which can be marred easily. Any scratch or defect in the polished surface will be transferred to the surface of glossy prints. The life of the drum is largely dependent on the care used in processing the prints. With extreme care, these drums have run 3 years in continuous operation, but they have run as little as 3 months when no regard was paid to instructions.

A drum, when worn out, may show many tiny pits from chemical action, or fine scratches about the circumference of the drum. If the cloth lip of the print tray comes in contact with the drum surface, the accumulation of dust in the cloth may cause serious scratches in the drum surface after only a few months of operation.

When prints stick to the dryer drum, it is usually because the emulsion is too soft. This can be caused by washing too long, washing at too high a temperature, or drying at too high a temperature (above 210°F). Sticking prints deposit emulsion on the drum surface, and this must be cleaned before additional prints are run, if a quality finish is to be expected. If the drum is hot, let it cool to room temperature before cleaning.

The presence of gelatin on the surface of the drum can be detected when the drum is wiped horizontally with a 2 percent solution of acetic acid. On clean areas, surface tension will cause the acetic acid to break into droplets; if gelatin is present, the surface will remain evenly wetted. Clean the drum with a mild detergent and rinse thoroughly before reuse. ONLY WHEN ALL ELSE FAILS SHOULD AN ABRASIVE OF ANY KIND BE USED. When an abrasive is necessary, use a mild silver polish. First clean the locally contaminated areas, and then the entire drum surface. This will remove the foreign matter and help restore the drum finish.

Lubricate the dryer in accordance with the manufacturer's instruction booklet; be extremely careful not to allow the oil to drop on the dryer apron.

Lubrication

Periodic lubrication of functional photographic equipment is usually a necessity, unless otherwise directed by instruction manuals and bulletins on the equipment. Exceptions include equipment that was permanently lubricated at the factory, or must be relubricated at depot level maintenance.

Wear

Wear occurs at points where friction is created, unless the correct amount and/or viscosity of lubricant is maintained at those points. If lubrication is to be performed, detailed and specific instructions are given as to the unit to be lubricated, lubrication points, the type of lubricant, the lubrication period, and the method of application. Follow these instructions carefully when lubricating equipment. It is often more harmful to the equipment to overlubricate or use the wrong weight of lubricant than not to lubricate at all. If a single drop of oil in a particular location makes that component work better, it does not necessarily hold true that two drops will make it work twice as well. You will likely end up with that extra drop of oil spread over the surface of a roll of film or in other places where it doesn't belong.

TROUBLESHOOTING

As senior photographers you should try to learn the correct procedure for diagnosing troubles so that you can assist in pinpointing trouble areas and planning any corrective and preventive action to be taken.

Operational and maintenance instructions contain troubleshooting tables. These tables are usually very complete and extremely helpful. However, it is impossible to foresee and cover all potential types of malfunctions. When a malfunction does occur, troubleshoot it using a system of careful analysis, not trial and error. Use the tables in the maintenance instructions whenever possible, but do not attempt repairing it until you have pinpointed the trouble, and even then make sure the repairs are within your capabilities.

Various types of electrical and electronic testing and troubleshooting sets are often available for the testing and troubleshooting of certain types and components of photographic equipment. These items can be anything from multimeters, oscilloscopes, tube testers, and vacuum tube voltmeters to elaborate camera control system test sets.

These items are not only useful, but often indispensable in the testing and troubleshooting of photographic equipment, and should be used whenever available.

Sometimes the Photographer's Mate will be in situations where either malfunctions cannot be located by testing and troubleshooting equipment or the equipment is not available. He must then use logic and inductive reasoning in pinpointing, diagnosing, and rectifying the trouble. Troubleshooting, to be successful, should not deteriorate to trial and error methods. Careful calculated analysis of the equipment and problem is required.

The photographer should first carefully examine the equipment so that he can answer two questions. First, what is the equipment doing that it shouldn't do? Second, what is the equipment failing to do, that it should do? Finding the correct answer to these two questions may not be so easy as it first appears. Don't be satisfied until you have obtained definite answers for each question. If the answer to either question is composed of several things, list them on paper so that you can refer to them as needed.

A third question must now be answered: What assembly, subassembly or component controls this action? After this question has been answered, ask a fourth question: What possible individual part(s) in this section might cause the problem? And finally the fifth and last question: If a certain part or component is defective as I suspect, would it cause this malfunction?

Troubleshooting a piece of equipment can be simplified if these questions are correctly answered, and the appropriate technical manuals and/or bulletins are utilized. These publications contain illustrations of the equipment and components, as well as operational, maintenance, and test procedures. In addition, a parts breakdown is also illustrated.

SURFACE GUNNERY EXERCISES

The determination of fall of shot by the photographic method for surface gunnery exercises of 3-inch caliber and greater may be generally separated into three categories: (1) photographic rakes, (2) reference ship method, and (3) firing ship method.

Photographic rakes are provided by taking still photographs from the stern of the ship towing the target. Rake results are an approximation of range error only.

The reference ship method employs three cameras, two set up on the towing ship and one on the reference ship, which is stationed a distance equal to tow target distance on the beam of the towing ship. This procedure gives a fairly accurate determination of range and deflection errors.

The firing ship method uses photographic observations made from the firing ship (rather than from a reference ship) and from the towing ship. Accurate phototriangulation by this procedure is possible for all surface gunnery exercises when the 40-inch lens is used on the Hulcher 70 Model 102 C camera on the firing ship.

SHIPS INVOLVED

The services of the following ships are necessary to provide camera platforms for the various phototriangulation situations:

1. Photographic rakes.
   a. Target-tow vessel.
2. Reference ship method.
   a. Target-tow vessel.
   b. Reference vessel.
3. Firing ship method.
   a. Target-tow vessel.
   b. Firing ship.

EQUIPMENT

The equipment required for surface gunnery exercises is as follows:

1. CAMERAS. Three 70mm Hulcher cameras, mounted on a special mount or hand held. Two 6-inch focal length lens Hulcher cameras are used on the tow ship. One 40-inch focal length lens Hulcher is used on the firing ship. Figure 14-5 shows three different focal length lenses which are available on the 70mm Hulcher Model 102 cameras.

2. POWER. This particular camera requires 115 volt a.c. to operate. CAUTION: Shock hazard exists if used on wet decks.

3. MECHANICAL RAKE. This instrument (fig. 14-6) permits the making of visual estimates of the range errors of the fall of shot. It is manned on the towing vessel by two men and measures range error by the geometric principle of similar triangles.

Mechanical rakes are not as accurate as photographic rakes. This is true because when more than two salvos fall at once the rakes cannot possibly be as accurate, due to the amount of time it takes to read each separate rake.

4. OTHER EQUIPMENT. Various other types of equipment, such as binoculars, recording sheets, and spare fuses, are required for the proper accomplishment of the mission.

ARRANGEMENT OF PERSONNEL AND EQUIPMENT

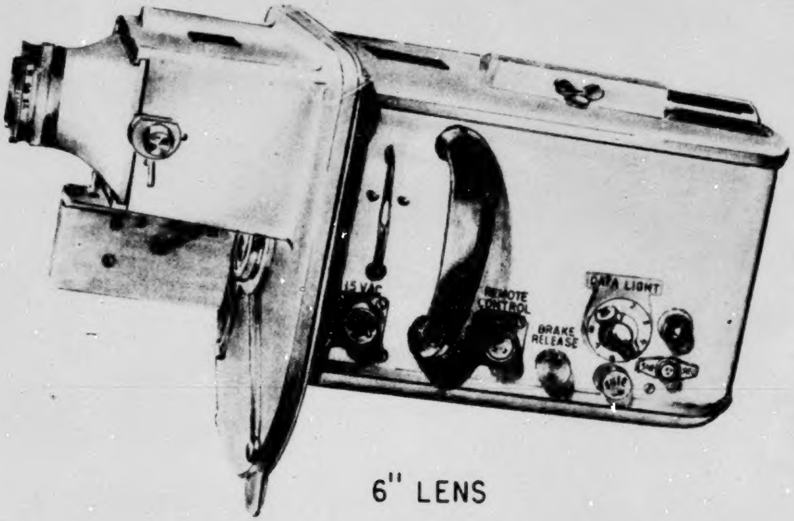
The proper arrangement of personnel is necessary to provide the best and most efficient coverage of all types of surface operations.

For the TOW SHIP (Photographic Rake) type of operation, three men are assigned to the tow ship and are positioned as illustrated in figure 14-7.

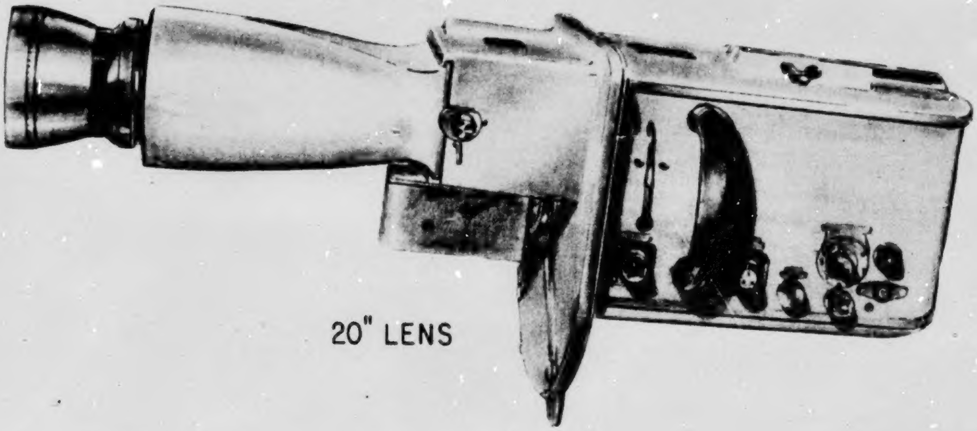
On the REFERENCE or FIRING SHIP, one man is assigned and positioned as shown in figure 14-8. (The FIRING SHIP method is most frequently used.)

FORMS

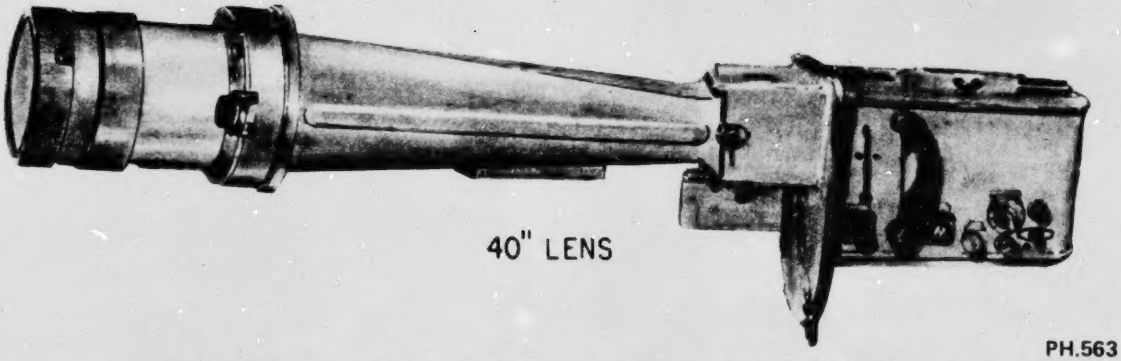
The information to be recorded for each of the vessels involved is recorded on data forms


115 VAC
REMOTE CONTROL
BRAKE RELEASE
DATA LIGHT

6" LENS



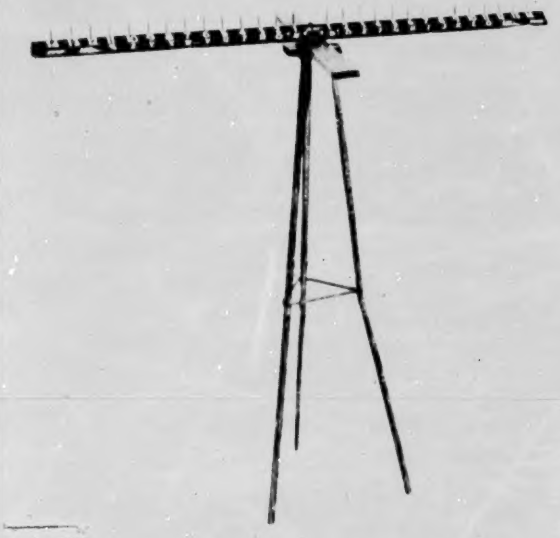
20" LENS



40" LENS

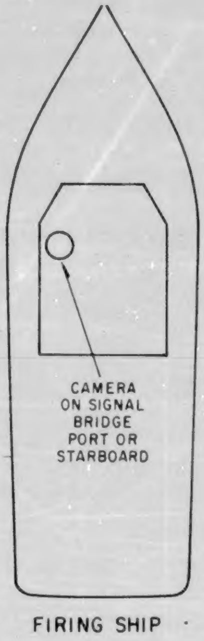
PH.563

Figure 14-5.—70mm Hulcher camera, model 102 with 6-, 20-, and 40-inch lens.



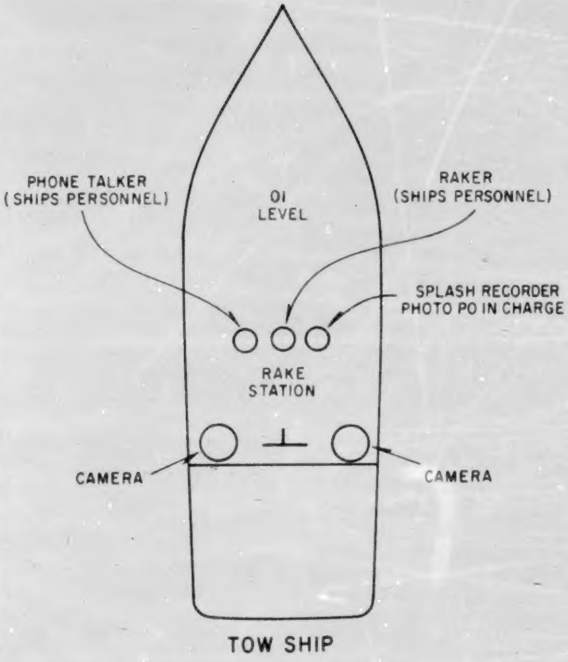
PH.564

Figure 14-6.—Mechancial rake.


CAMERA
ON SIGNAL
BRIDGE
PORT OR
STARBOARD
FIRING SHIP

PH.566

Figure 14-8.—Reference or firing ship personnel and equipment.

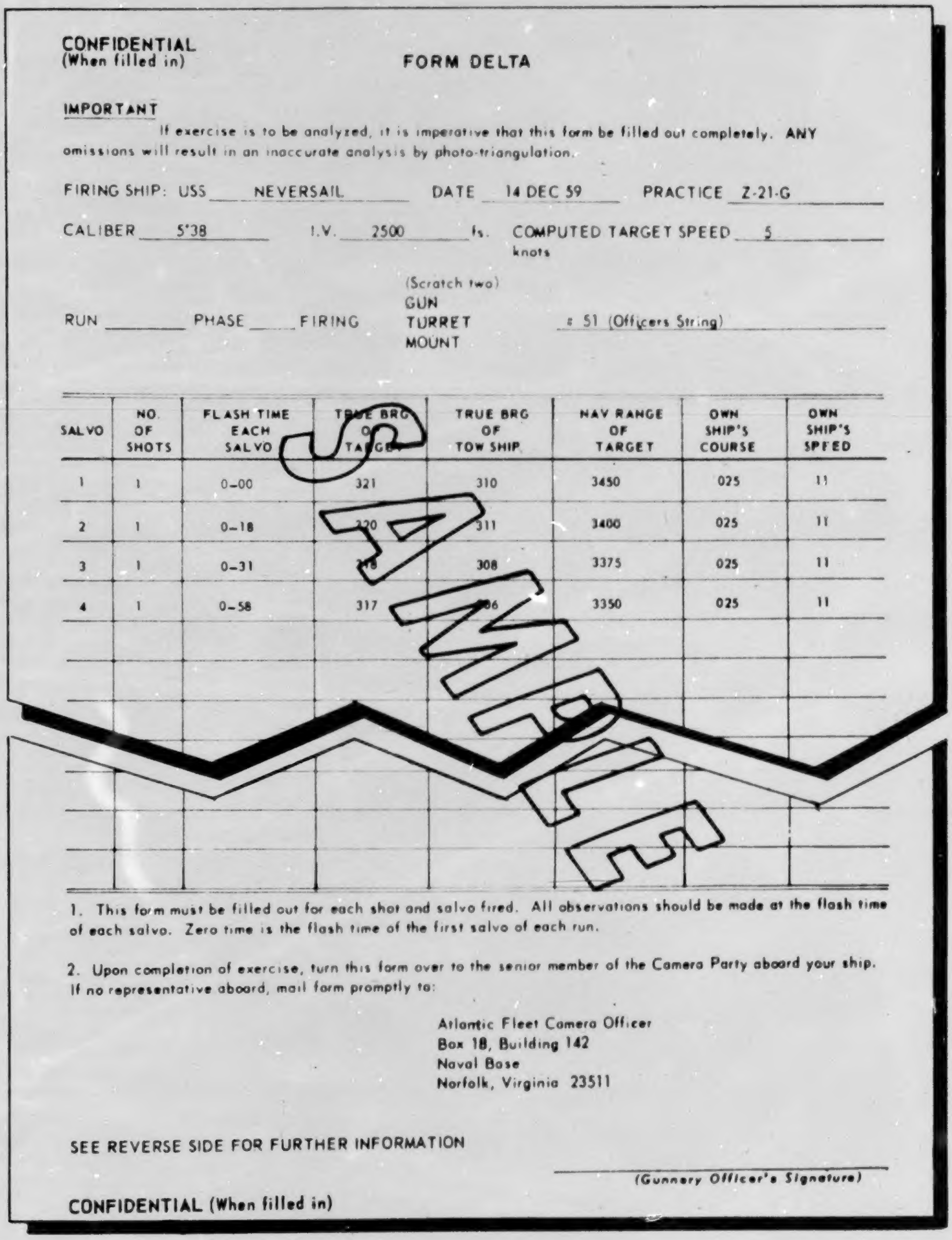

PHONE TALKER
(SHIPS PERSONNEL)
01
LEVEL
RAKER
(SHIPS PERSONNEL)
SPLASH RECORDER
PHOTO PO IN CHARGE
RAKE
STATION
CAMERA
CAMERA
TOW SHIP

PH.565

Figure 14-7.—Tow ship personnel and equipment.

furnished by the photographer in charge. The following sample forms are those used by the Atlantic Fleet Combat Camera Group. Along with the data forms, the photographer furnishes information sheets concerning the methods of phototriangulation. It is very important that all these forms be properly filled out. (Forms other than those provided are of no use.) Without all the completed forms from the tow ship and the firing or reference ship, phototriangulation is impossible.

1. Form DELTA (fig. 14-9). Used in the FIRING SHIP method of phototriangulation.
2. Rake sheet (fig. 14-10) Used in conjunction with Form 1 in the TOW SHIP method of phototriangulation.
3. Form 1 (fig. 14-11). Used with the RAKE sheet above. This form, when properly completed, furnishes the necessary information for phototriangulation in the tow ship method.



CONFIDENTIAL
(When filled in)

FORM DELTA

IMPORTANT

If exercise is to be analyzed, it is imperative that this form be filled out completely. ANY omissions will result in an inaccurate analysis by photo-triangulation.

FIRING SHIP: USS NEVERSAIL DATE 14 DEC 59 PRACTICE Z-21-G

CALIBER 5"38 I.V. 2500 fs. COMPUTED TARGET SPEED 5 knots

RUN ________ PHASE _____ FIRING (Scratch two) GUN TURRET MOUNT # 51 (Officers String)

SAMPLE

SALVO	NO. OF SHOTS	FLASH TIME EACH SALVO	TRUE BRG OF TARGET	TRUE BRG OF TOW SHIP	NAV RANGE OF TARGET	OWN SHIP'S COURSE	OWN SHIP'S SPEED
1	1	0–00	321	310	3450	025	11
2	1	0–18	320	311	3400	025	11
3	1	0–31	318	308	3375	025	11
4	1	0–58	317	306	3350	025	11

1. This form must be filled out for each shot and salvo fired. All observations should be made at the flash time of each salvo. Zero time is the flash time of the first salvo of each run.

2. Upon completion of exercise, turn this form over to the senior member of the Camera Party aboard your ship. If no representative aboard, mail form promptly to:

Atlantic Fleet Camera Officer
Box 18, Building 142
Naval Base
Norfolk, Virginia 23511

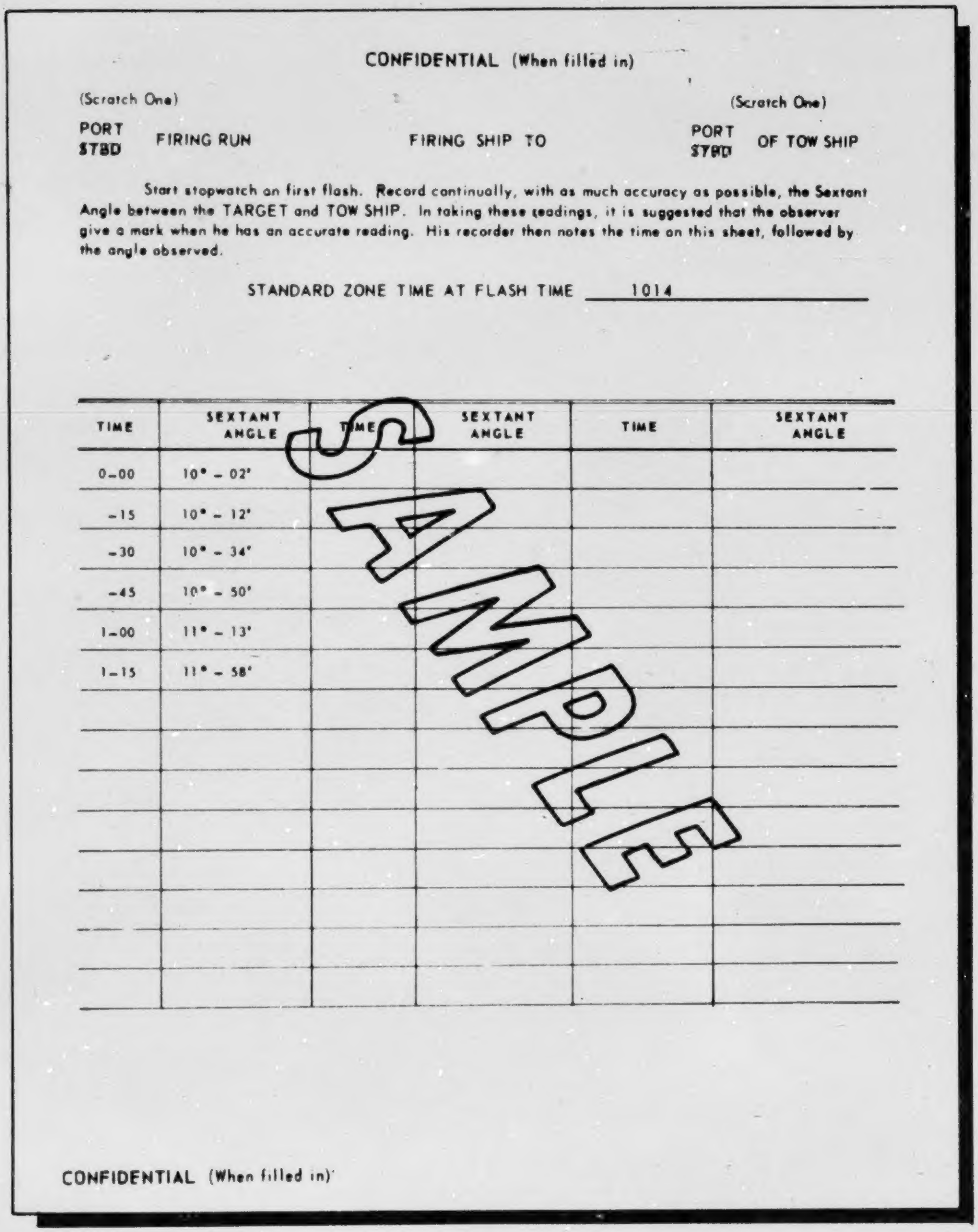
SEE REVERSE SIDE FOR FURTHER INFORMATION

(Gunnery Officer's Signature)

CONFIDENTIAL (When filled in)

PH.567

Figure 14-9.—Form delta.



CONFIDENTIAL (When filled in)

(Scratch One)

PORT
STBD FIRING RUN

FIRING SHIP TO

(Scratch One)

PORT
STBD OF TOW SHIP

Start stopwatch on first flash. Record continually, with as much accuracy as possible, the Sextant Angle between the TARGET and TOW SHIP. In taking these readings, it is suggested that the observer give a mark when he has an accurate reading. His recorder then notes the time on this sheet, followed by the angle observed.

STANDARD ZONE TIME AT FLASH TIME 1014

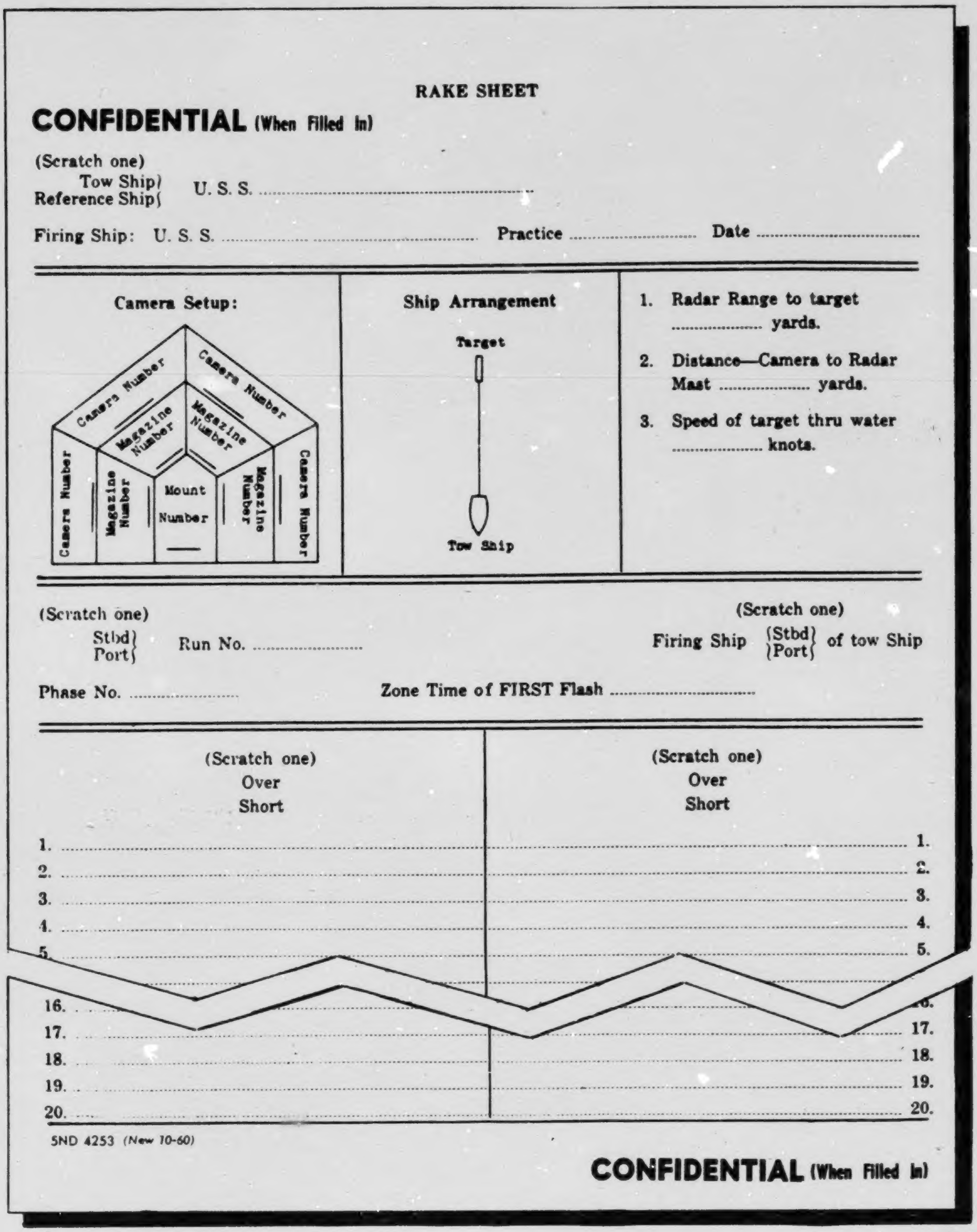
TIME	SEXTANT ANGLE	TIME	SEXTANT ANGLE	TIME	SEXTANT ANGLE
0-00	10° - 02'				
-15	10° - 12'				
-30	10° - 34'				
-45	10° - 50'				
1-00	11° - 13'				
1-15	11° - 58'				

SAMPLE

CONFIDENTIAL (When filled in)

PH.568

Figure 14.9—Form delta—continued.



RAKE SHEET

CONFIDENTIAL (When Filled In)

(Scratch one)
Tow Ship / Reference Ship U. S. S. ....

Firing Ship: U. S. S. .... Practice .... Date ....

Camera Setup:

Camera Number
Camera Number
Camera Number
Camera Number
Magazine Number
Magazine Number
Magazine Number
Magazine Number
Mount Number

Ship Arrangement

Target
Tow Ship

1. Radar Range to target .... yards.
2. Distance—Camera to Radar Mast .... yards.
3. Speed of target thru water .... knots.

(Scratch one)
Stbd / Port Run No. ....

(Scratch one)
Firing Ship Stbd / Port of tow Ship

Phase No. ....

Zone Time of FIRST Flash ....

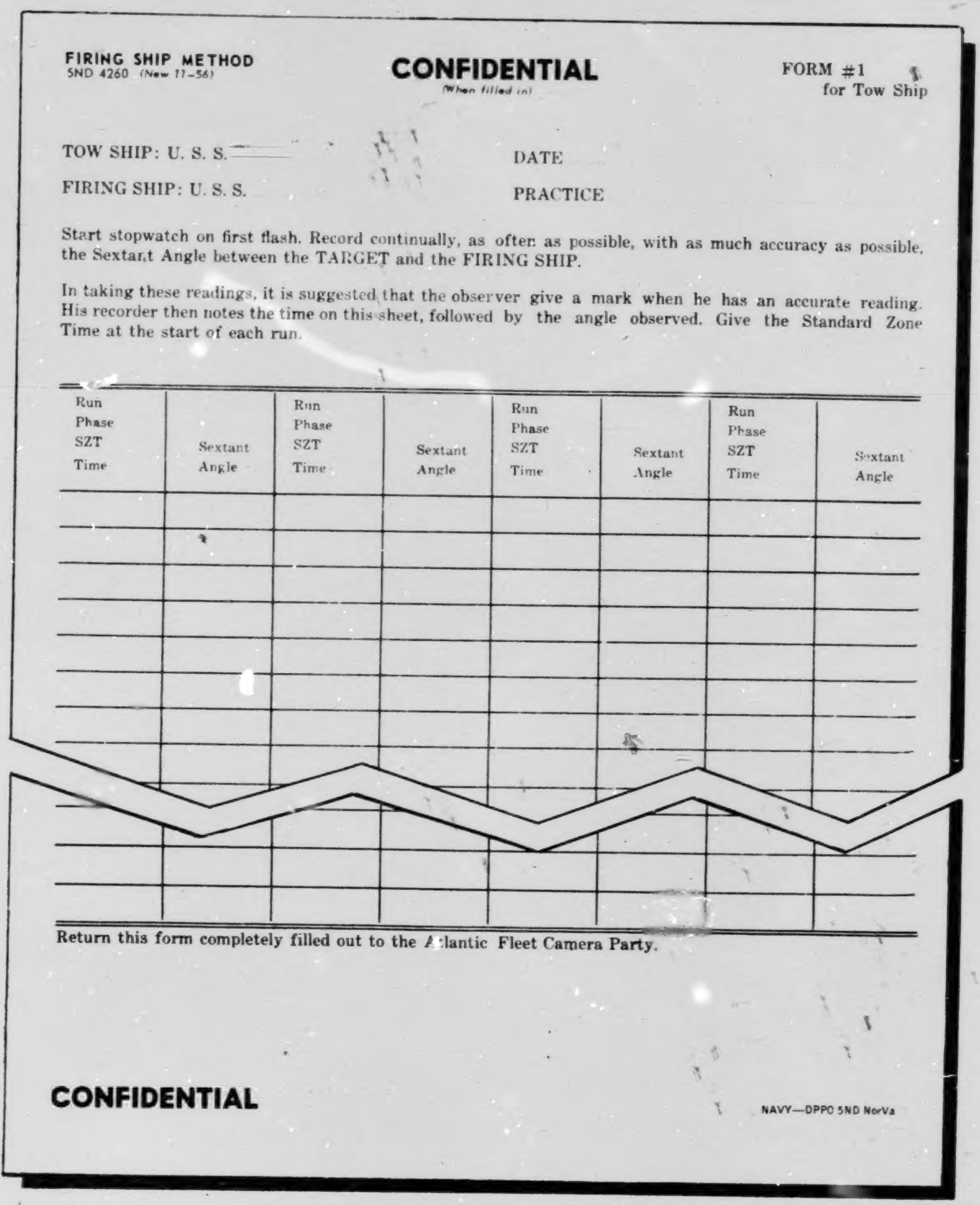
(Scratch one) Over Short	(Scratch one) Over Short
1.	.... 1.
2.	.... 2.
3.	.... 3.
4.	.... 4.
5.	.... 5.
16.	.... 16.
17.	.... 17.
18.	.... 18.
19.	.... 19.
20.	.... 20.

5ND 4253 (New 10-60)

CONFIDENTIAL (When Filled In)

PH.569

Figure 14-10.—Rake sheet.



FIRING SHIP METHOD
5ND 4260 (New 11-56)

CONFIDENTIAL
(When filled in)

FORM #1
for Tow Ship

TOW SHIP: U. S. S.

DATE

FIRING SHIP: U. S. S.

PRACTICE

Start stopwatch on first flash. Record continually, as often as possible, with as much accuracy as possible, the Sextant Angle between the TARGET and the FIRING SHIP.

In taking these readings, it is suggested that the observer give a mark when he has an accurate reading. His recorder then notes the time on this sheet, followed by the angle observed. Give the Standard Zone Time at the start of each run.

Run Phase SZT Time	Sextant Angle	Run Phase SZT Time	Sextant Angle	Run Phase SZT Time	Sextant Angle	Run Phase SZT Time	Sextant Angle

Return this form completely filled out to the Atlantic Fleet Camera Party.

CONFIDENTIAL

NAVY—DPPO 5ND NorVa

PH.570

Figure 14-11.–Form 1.

DETERMINING THE FALL OF SHOT

Using the forms listed above (if they have been properly filled out) provides all the information required to compute the fall of shot. The methods of phototriangulation are improving, with new and faster equipment and methods being researched in an effort to keep pace with the technological advances in gunnery and photography.

ADVERSE WEATHER PHOTOGRAPHY

The discussion of adverse weather photography in the following paragraphs includes cold weather photography and tropical weather photography.

COLD WEATHER PHOTOGRAPHY

The value of aerial photography as an aid in exploring and mapping the earth's surface is well recognized. In cold weather areas, most of which are still poorly mapped and explored, its value in these respects is even greater. Performance of field work in cold weather areas is rendered uniquely difficult by a number of factors, including inclement weather, rugged terrain conditions, and unusual logistics problems. For these reasons the explorer or mapper of a cold weather area is in need of some means by which detailed, reliable information relative to large portions of the earth's surface can be permanently recorded in a short period of time. Aerial photography is by far the best means currently available for fulfilling this need.

Trimetrogon aerial photography is useful in the geographical exploration and mapping of cold weather areas because it renders horizon-to-horizon coverage, resulting in the minimizing of ground control and related field work so necessary for the photogrammetric compilation of maps. Trimetrogon photography and the new panoramic photography provide extensive mapping coverage in a short period of time.

Terrestrial or ground photography is not widely used in the geographical exploration of cold weather areas. However, ground photography has usefulness to an expedition in that it has certain specific and related value as supplemental material to coverage photographed from the air.

Aerial photography, in general, is used for detecting certain physical characteristics of ice and snow. One example is the detection of buried crevasses which are serious hazards to surface travel. Often, ice or snow forms bridges over crevasses and sinks to a depth of only a few inches below the surrounding area. These depressions are easily identifiable on aerial photographs taken at the proper angle.

Photographs are valuable as a means of familiarizing troops with conditions they will encounter on terrain of this type. They are also useful in acquainting logistics personnel with pertinent problems to be encountered in cold weather areas. Motion picture photography has proved to be an excellent and effective way to illustrate the recommended techniques for traversing hazardous terrain, for survival in a blizzard, etc.

Aerial photographic reconnaissance constitutes an excellent source (frequently the only source) from which the nature and extent of enemy military activity can be determined. It is ideal for determining the nature and extent of possible enemy military activity.

For many years aerial reconnaissance has been the method employed to obtain reconnaissance study data of inaccessible areas. Aerial photographic coverage of polar areas, originally had but three principal uses by the military analyst, scientist, and explorer. These uses were for field orientation and planning, for mapmaking, and for informational purposes. The use of polar aerial photography now makes it possible for photographic interpreters to examine photographic coverage in such detail that accurate area descriptions and geographical analyses will always be available.

The use of color photography in the Antarctic area first took place during the U.S. Antarctic Service Expedition of 1939-40. Color photographs enabled interpreters to distinguish many features in snow and ice terrain that were not revealed in black-and-white photography in the rendition of surface textures, the presence and depth of melt-water, snowbridges, crevasses, manmade tracks, dwellings, and other installations difficult to discern on black-and-white photos.

The purpose of the cold weather photographic instructions contained in this chapter is to familiarize the naval photographer with the unusual conditions and possible hazards he will meet on this type of assignment.

CLIMATE CONDITIONS AND THEIR EFFECTS ON MAN AND EQUIPMENT

Temperatures in polar regions in winter months may range from -10°F to -90°F, and in summer, from below freezing to +50°F. In some locations, these extremes of summer and winter temperatures may be separated by 125°F.

There is very little rainfall in these regions, and precipitation in any month of the year may be in the form of snow. Severely cold temperatures are nearly always accompanied by readings of relatively low humidity.

The reduced moisture in the air, as a result of low temperature, allows sound to be transmitted more freely; so sound traveling from considerable distances in cold climates seems to be coming from nearby sources. On the other hand, a snow cave, crevasse, or similar site will absorb sound so completely that it is necessary to shout in order to be heard from a relatively short distance.

Also, because of its low water vapor content, the Antarctic atmosphere is relatively more transparent, making it possible to see farther than in normal temperatures. This makes it difficult to judge accurately the sizes and distances of objects, especially where there are no familiar adjacent objects to serve as guides.

Also, because of the low water vapor content, the Antarctic atmosphere is relatively transparent to long-wave heat radiation. Except in a narrow portion of the infrared spectrum, atmospheric water vapor strongly absorbs long-wave radiation originating at the earth's surface and reradiates much of it back to the surface.

Strong winds and gales occur in all seasons. The most severe (35 to 150 miles per hour) may be experienced in the autumn, winter, and spring months. In the north polar regions, high winds are encountered generally within 35 to 50 miles of the coast; winds in the interior regions are mild.

A distinctive feature of these polar winds is the acceleration in the rate of their cooling effect. Although temperatures may be comparatively mild, high winds create a wind and temperature combination known as wind-chill. The wind-chill index is the actual temperature minus one degree per knot of wind. EXAMPLE: -30° with 10 knots of wind = -40° equivalent, or -40° wind-chill index. This effect makes the weather more uncomfortable than in other cold regions where wind velocities are lower.

High surface winds blow loose snow off the ice surfaces and cause blizzard conditions near the ground. The blowing snow tends to obscure terrain detail.

CHARACTERISTICS OF WHITE-OUTS

White-outs are prevalent in polar ice areas whenever there is an overcast. On these days it is impossible to distinguish surface irregularities regardless of their conformation, unless there is a discoloration of some sort present. White-outs are most disappointing to a photographer, because it is virtually impossible to expose correctly for other than nearby colored objects. There are no shadows, and white will not photograph well. Exposures of persons or objects which absorb any degree of light will produce an image on the negative, but the photographic results create the illusion that either the images are hanging in space or that the prints have been bleached except for the images of the subjects. Because of the lack of shadows, it is very difficult to distinguish the surface. The ice and snow surface cannot be seen until there is undiffused sunlight to cause its irregularities to cast shadows. Photographing away from the base is difficult because there are no objects of familiar size and shape (antenna towers, huts, tents, etc.) which show the relative size of the subjects being photographed.

The polar photographer experiences much confusion and many problems when it becomes necessary for him to photograph during white-outs. The usual problem of getting adequate shadow detail encountered in ordinary photography is not present during white-outs, since there are no shadows. The omnidirectional diffused light results in a short scene brightness range. Overexposure should be avoided, as well as underdevelopment of the negative.

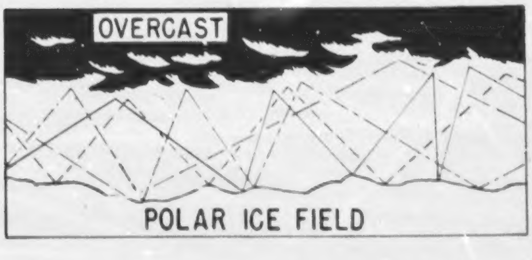
Another unusual feature is the fact that there is more light prevalent on the snow surface during a polar overcast day than there is on a clear, bright, sunshiny day, assuming the sun is at equal elevations on both days. The reason for this deceptive condition is due to light penetrating through the overcast and striking the white surface where it is almost entirely reflected back to the overcast. The light is then re-reflected by the white of the bottom of the overcast back to the snow surface, then to the overcast again, etc., with a resultant buildup of light intensity. The cumulative effect of this buildup is reached almost immediately whenever these conditions occur, because of the speed of light, and because each time that any of the light is reflected, some of the amount of effective light is lost. Polar photographers refer to results of this strange phenomenon as a "buildup of light.' Polar expedition personnel describe it as an ' intense, blinding light.' Figure 14-12 illustrates the reflection of sunlight on an overcast day in polar ice field areas. The result is light buildup.

On a bright, clear day, the visual sunlight is reflected normally by snow and ice into the free atmosphere. Shadows which give contrast and delineate detail are reproduced when exposure is made with the sunlight lighting the scene from the side or from behind the subject.

COLD WEATHER PROBLEMS

Basic Problems

The Dakotas, Montana, and Minnesota are frequently colder than Point Barrow, Alaska, or NAF, McMurdo Sound, Antarctica. It is the effective temperature and altitude at which men and equipment must work which are the most significant factors. The effective temperature (or wind-chill index) as previously described is the actual temperature minus one degree per knot of existing wind. The lower the wind-chill index and the higher the altitude, the sooner man will fatigue. Most equipment will be affected more by temperatures than altitude changes.



PH.571

Figure 14-12.—Reflection of light on overcast or white days.

Personal Hazards

The personal hazards encountered in cold weather climates are discussed here for the purpose of familiarizing the naval photographer with the conditions which may cause severe discomfort or even serious injury when serving on a polar or cold weather assignment.

FATIGUE.—Because of prolonged intervals of bad weather, all photographers have long duty assignments during those clear periods when film can be exposed "around the clock." Excessive fatigue can be caused by wearing heavy, bulky outer clothing; by handling equipment while wearing hand coverings which impede easy handling and operation of equipment; by any physical exertion required at high altitudes; or by extended periods of exposure to extreme cold. Personnel and equipment reactions to the low temperatures in the polar regions are parallel in many respects to those apparent when the low temperatures of high-altitude flight are encountered. All parts of aerial cameras, as well as the motions required to operate them, should be as simple as possible. High altitudes make breathing more difficult. This condition, plus the fact that any exertion in low temperatures is always more difficult because normal reactions are slowed down, makes cold weather camera operation a very laborious assignment.

FROSTBITE.—The danger of frostbitten fingers is always present whenever it is necessary to remove heavy bulky outer gloves or mittens in order to make equipment adjustments. The use of lightweight cotton gloves keeps hands from sticking to bare metal; but at temperatures below -30°F, these thin gloves do not provide any warmth. It is not safe to remove the hands from the heavy outer coverings for more than a minute or two at a time, even though heavy gloves hinder or make impossible the manipulation of levers, dials, and other adjustments. Frostbite can occur from perspiration produced during periods of exertion and the subsequent freezing of clothing during comparatively inactive periods which may follow, as well as from exposure to (or insufficient protection from) low temperatures.

FROSTBURN.—Frostburn may result from facial skin coming in contact with unpainted or unenameled metal surfaces when using the camera eyepiece, or by touching the back of the camera. This can be avoided by attaching a layer of chamois, thin felt, a thin coating of dope or lacquer, or other similar material to those areas so as to provide insulation against cold bare metal.

CLOTHING.—Photographic personnel should always wear clothing that provides freedom of movement as well as adequate protection against the cold. Excessive clothing is frequently dangerous. The fatigue point is increased by weight and bulk; one sweats when actively engaged, and this moisture freezes when standing still. Goggles or dark glasses should always be worn as protection against intense glare from the snow and ice. They should also be worn as protection against the diffused light of Arctic white-out or Antarctic snowblind conditions. The eyes are particularly sensitive to the light prevalent on bright cloudy days, as well as on bright clear days. If the eyes are not protected from the intense light, temporary blindness will probably result, followed by severe headaches. Permanent eye injury can follow frequent periods of exposure to such injurious conditions for long periods of time.

EQUIPMENT WINTERIZATION

Winterized equipment may be identified as that which has been conditioned to operate satisfactorily at temperatures as low as −65°F.

All photographic equipment (aerial, motion picture, and still) must be cold weather conditioned before it is used in such low temperatures. This special treatment is required to minimize malfunctioning (due to congealment of lubricants or to contraction of components) to preserve the quality of the equipment, and to obtain the greatest degree of operational efficiency in cold temperatures.

Cold Contraction

When equipment is subjected to low temperatures, the contraction variables of the different materials may cause binding or dragging which, in the case of motion picture cameras, can result in intermittent surges in speed. This is detected audibly by squeals, because the contraction tightens two or more parts together more firmly; or, if the materials are adjacent, too great a tolerance, detected audibly and visibly by chattering and wobbling, may be noticed.

Moisture Condensation

Condensation is formed when cold objects are brought into contact with warm air. The warm air (which has a higher moisture content than cold air) is immediately chilled and gives up its moisture which deposits on the cold object. Although this moisture can be wiped off accessible external surfaces, it penetrates into all areas and can cause permanent damage. In extremely cold climates, the end result of condensation within equipment is always the same—EQUIPMENT FAILURE. The degree of damage done at any instant of time by condensation is difficult to ascertain; therefore, it is often overlooked. A piece of equipment may fail immediately, a week later, or years later, depending on location and extent of the condensation within.

Remember, a person can move from cold to warm freely, but his equipment cannot. Equipment, especially delicate mechanical equipment, must be brought up to temperature at a rate slow enough that condensation will not occur.

CAUTION: Never place cold film in a warm camera; and never place warm film in a cold camera.

Do not breathe on cold lenses, eyepieces, and focusing screens, either intentionally or accidentally. In low temperatures, warm breath becomes fog which forms frost on contact with cold glass and metal. This is time consuming and difficult to remove without injury to the lenses.

Cold Storage

Photographic equipment should be stored in temperatures which approximate those in which it will be used. This will lessen the chances of its becoming damaged by the formation of moisture from condensation when taken from cold to warmth. Equipment which will be used outdoors should be kept exposed to sufficient cold at all times to prevent condensation.

Precautions

All cameras and photographic equipment to be operated in polar regions as well as at cold, high altitudes should have been previously tested for operation at these temperatures.

The use of treated leather, plastics, and natural or synthetic rubber not designed for cold weather use should be avoided whenever possible; these substances tend to become brittle at very low temperatures. Cameras with treated bellows should be handled with care; light leaks are apt to occur if the bellows material should crack from freezing.

Camera Covers

Keep cameras covered when not in use, especially during periods of blowing snow, to prevent the dustlike snow particles from entering the camera mechanism and causing damage. Although it is never good practice to daylight-load film, a camera cover used as a light hood will help minimize possible fog damage.

Effective winterization of photographic equipment requires that it be handled in the following manner:

1. Clean thoroughly and accomplish relubrication with cold weather lubricants.
2. Perform any special adjustments to compensate for contraction or other cold weather reactions.
3. Apply special techniques for handling, storing, and processing of film and equipment during cold weather operations.

All cameras designed for operation in normal temperatures will usually operate effectively without winterization in low temperatures when taken from a warm place, such as a warm building or a warm pocket, into the cold for a very short interval and then returned promptly to warmth. This is because the camera never gets sufficiently cold to cause malfunctions. However, any camera or piece of camera equipment which is to be used for extended periods in temperatures of +20°F or lower, should receive special cold weather treatment.

Lubricants

The low-temperature lubricants recommended for use when winterizing cameras and other photographic equipment, unless otherwise specified, are: MIL-G-3278 (formerly AN-G-25 grease); MIL-O-6085 (formerly AN-O-11 oil); and powdered or flake graphite.

Oils and greases developed expressly for the winterizing of equipment have a low pour point, a low rate of viscosity change, a freedom from corrosion action, low volatility, and low rates of evaporation.

Low-temperature lubricants must possess a viscosity with minimum resistance to change in the shape or arrangement of the molecular structure; i.e., does not "congeal." Lubricants not specifically developed for cold weather use congeal and retard or brake the motion of the moving parts instead of facilitating it.

Cold weather lubricants also must be capable of diffusion over all surfaces requiring lubrication and permeation of the pores and surface cracks of metal. Cold weather lubricants evaporate at a more rapid rate than do regular lubricants at low temperatures. Their tendency to dry out requires frequent checking of lubricated surfaces and repeated replenishment.

Most synthetics such as silicon products are temperature inert in the region of -65°F to +140°F. Dow Corning's 510 silicon oils and Number 33 silicon greases are very satisfactory cold weather lubricants.

Cleaning

Equipment must be thoroughly cleaned of all previously applied lubricants. The complete removal of lubricants will require disassembly of the photo equipment so that the thorough cleaning of its parts and the elimination of all grease and oil residue can be assured. Cleaning solvent (511) should be used to remove old lubricants from equipment. Do not use carbon tetrachloride, lead-free kerosene, dry-cleaning naphtha, or other solvents. Care should be taken to prevent solvent from touching those parts which may be injured; i.e., lenses and other optical parts, leather, fabrics, and rubber. Scum and oily residue which may harm film should also be completely removed from any part of the gear which comes in contact with film.

After all components are thoroughly cleaned and dried, low-temperature lubricants are applied and the equipment reassembled.

Inspection

Complete cold weather relubrication is recommended whenever it will increase the operating efficiency of the equipment. The degree of use the equipment receives and often the location of the cold weather operations are factors which will determine if relubrication is necessary. Lubrication inspection should be made at least every 30 days, and complete relubrication should be performed as necessary. This is necessary in the polar regions because the lightweight, low-temperature lubricants tend to evaporate rapidly in dry climates.

COLD WEATHER EQUIPMENT

Most of the photographic equipment and accessories intended for cold weather operations are presently manufactured to meet rigid temperature specifications, which qualify them for operation between -65°F and approximately 120°F. Consult the operating instructions manual for the particular piece of equipment to determine its operating temperature limits.

Cameras

Efficient operational clearances at low temperatures are a part of aerial camera specifications. The only special cold weather conditioning required by most of these cameras to insure their satisfactory operation is thorough removal of all old lubricants, particles of dust or grit, and metal or other foreign matter which may cause malfunctioning of the equipment, and relubrication with special cold weather lubricants.

The choice of motion picture cameras to be used on a cold weather assignment is determined by the conditions which govern the picture taking operation. These conditions are the degree of cold; the length of time the cameras will be subjected to the cold, and whether wind-chill will be a camera-cooling factor; the distances the equipment must be transported; the type of available transportation; and whether covers or any type of heater for the cameras are to be used.

The speed and the timing of each camera motor are very important and should be checked frequently, since cold motors do not run at normal speeds. All motion picture cameras used in cold weather operation should be checked periodically with a tachometer to insure correct fps rate. Generally, the electrically powered, standard 35mm cameras operate more reliably and with less speed variation in subzero temperatures than the spring-driven cameras. However, their motors and power supplies are not generally available in remote areas, and they are not useful for shooting news photography where crowds or carrying distances are major factors.

The material appearing in NavAer 10-1-752, which is pertinent to still cameras, comes mainly from evaluations based on reports of their use on polar expeditions under actual cold weather operating conditions, and from evaluations resulting from various laboratory tests. Some handbooks for those cameras listed may contain limited cold weather preparation or winterizing instructions.

There are some cameras, such as the gun cameras and radarscope recording cameras, which have been used by the U.S. Navy on cold weather operations and which do not require winterizing or special cold weather preparation, since they are equipped with built-in heating elements.

Lenses

Moisture of any type forming on a cold lens freezes immediately, and it is difficult to remove in subzero temperatures. A protective cover, such as a UV filter, is recommended for each lens. This also prevents the lens barrel from filling with snow which may or may not be easily removed. A careless method of its removal (gloves, rags, brushes, sticks) could easily result in permanent lens damage.

Filters

Filters are of the utmost importance for use in color photography in the polar regions. They also are important in black and white photography as a means of controlling contrast of the sky.

Glass filters should be handled and cared for in the same manner as lenses. They are precision made items and are subject to damage.

Viewfinders

If the glare coming through the viewfinder (when used in polar regions) is too great, filters to reduce it should be used.

Power Supply

Power supplies provide power for the lighting of the subjects to be photographed, or for camera operation, and are vital to the operation of equipment carried on a cold weather operation. Each power supply must be given special handling or treatment when it is to be used at low temperatures.

Dry cell batteries used for cold weather operation should be of a high energy type. As a battery cools off, its amperage output is reduced. At -40°F, a good flashlight battery is inoperative.

Most still hand cameras can be powered by standard batteries carried close to the body. This requires a remote battery case and cord. Body heat keeps the batteries operative and simplifies all other problems.

Film

Generally, cold temperatures as such do not injure film emulsions. Rollfilms having acetate bases become brittle and difficult to handle at extremely cold temperatures. However, acetate base films have been used satisfactorily at -65°F. As most photography is shot above -20°F, this is not considered a major problem.

Film supported with a Mylar, Estar, or Cronar base is relatively impervious to changes in temperature. Therefore, if the emulsions desired are available on these bases, they are more desirable for cold weather operation.

TROPICAL WEATHER PHOTOGRAPHY

The U.S. Navy also has Photographer's Mates who are stationed in tropical and near tropical regions or on photographic missions in these areas. In these areas photography is complicated by such factors as heat, humidity (dampness), insects, and dust or sand.

Conditions are equally as unpleasant to work under in the tropics as in the arctic regions and more detrimental to photographic equipment.

The high humidity that is prevalent in the tropics is especially injurious to photographic equipment and is responsible for corrosion, fungus, rust, mildew, mold, and warping.

Humidity and temperature where the photographic material and equipment is stored can be lowered by the proper use of air conditioning. Air conditioning not only helps insure favorable and constant storage conditions but also will diminish many of the other problems facing the photographer in the tropics. However, if circumstances do not permit air conditioning other means for lowering the relative humidity must be used. Photographic equipment can be placed in an equipment storage cabinet having four or five 200 watt electric light bulbs which burn continuously. The air inside the cabinet will be of the same absolute humidity as the air outside; however, the higher temperature produced by the heat from the lamps will lower the relative humidity inside a cabinet containing about 200 cubic feet of space. Equipment that has been properly cleaned and dried will not corrode or rust in a properly designed storage cabinet. Neither will mold or mildew form on leather or fabric parts. Photographic films and papers, however, must not be stored in a heated storage cabinet as they must be kept at both a low temperature as well as a low relative humidity. Details regarding the correct storage of photographic sensitized emulsions and chemicals can be found in chapters 5, 8, 17, and 20 of the PH 3 and 2 Rate Training Manual, NavPers

10355-A. Additional information regarding storage of processed sensitized materials, equipment, and the processing of film and paper is provided in this chapter.

STORAGE OF PROCESSED SENSITIZED MATERIAL

The high temperatures and humidity found in the tropics are conducive to both insect damage and a fungus growth in the emulsion of sensitized materials. This fungus growth can be prevented by coating the emulsion with film lacquer containing a fungicide. Most brands of film lacquer on the market today contain a fungicide. Before the emulsion is coated with a thin coating of lacquer it must be well cleaned and dried to prevent sealing in dust or dirt that might be on the film. Such foreign material would be impossible to remove without damaging the film after the lacquer has dried.

If the material is not completely dry, film lacquer will seal in the moisture. This results in failure to prevent fungus growth; in fact, it stimulates their growth. In addition to preventing the growth of fungus in the emulsion of processed sensitive material, film lacquer also protects the surface of film from surface abrasions during handling, with reasonable care.

Single kraft paper envelopes that have been impregnated with a 2 percent solution of sodium pentachlorphenate (a fungicide) are very satisfactory to use for the storing of negatives and prints that are in fairly regular usage. The envelopes (preservers) used to hold negatives and prints should have narrow edge seams instead of a single center seam. Certain glues used to seal the seams of preservers are very hygroscopic. Under conditions of high humidity these seams will not hold, resulting in the preservers falling apart.

Color transparencies are especially susceptible to fungus growth and attack by certain emulsion eating insects. They should, if at all possible, be lacquered and kept in as cool, dry, dark a place as possible.

Processed motion picture film must be carefully washed during processing to remove any residual traces of processing chemicals. If an air-conditioned storage space is not available, then the film (after being carefully dried) should be stored in motion picture film cans and sealed with tape to prevent the entry of humid air.

If a drying agent such as silica gel is included in the film can, care should be taken that the film does not become so dry that it will be brittle. Motion picture film should always be stored in a horizontal position so that the weight of the film will be on the edge of the roll.

STORAGE OF PHOTOGRAPHIC EQUIPMENT AND MATERIALS

All photographic equipment and materials should be kept as clean, cool and dry as conditions permit, and inspected at least weekly for any signs of dust, corrosion, mildew or fungus growth. All external metal parts should be covered regularly with a corrosion and rust preventive such as WD-40. Leather and cloth parts should be treated with a 3 percent shellac or lacquer containing 1 percent mercuric chloride to prevent fungus growth and the bellows should be treated with an approved leather dressing.

In sandy and/or dusty regions, lenses when not in use should be protected by a lens cap, and during use by a clear glass or a haze filter.

The construction of equipment is important in the tropics, Aluminum tends to corrode and of course unprotected iron will rapidly rust. Joints should be fastened with rustless screws and glued joints avoided.

The construction of equipment is important in the tropics. Aluminum tends to corrode and of course unprotected iron will rapidly rust. Joints should be fastened with rustless screws and glued joints avoided.

The package or box containing color film from the manufacturer must remain sealed (unopened) until the film is actually required to be used. Do not store exposed, unprocessed color films. After exposure color films should be processed as soon as possible to avoid shifts in the color balance and a possible fading of the latent image.

Whenever possible photographic chemicals should be obtained in an anhydrous form. Sodium sulphite, sodium hydroxide, potassium carbonate and other crystalline chemicals that will deliquesce absorb so much moisture from the air that they will dissolve in it. Deliquescent and efflorescent chemicals (crystalline chemicals that give up so much of their waters of crystallation to the air that they turn into an amorphous powdery state) such as sodium carbonate and sodium sulphate should be placed in dark bottles filled to the neck, waxed sealed and stored in a cool dark place.

Information regarding the tropical processing of photographic films may be found in chapter 9 of the PH 3 & 2 Rate Training Manual, NavPers 10355-A, and also in the Photo Lab Index.

EXPOSING FILM IN TROPICAL CLIMATES

A common erroneous impression prevalent among many photographers is that the illumination level and intensity of light is greater in the tropics than in temperate climates, so more light is available for film exposure. Therefore if the basic exposure for a roll of film having an exposure index of 100 was 1/100 second at f/16 in temperate climates it should be rated, according to this theory, at an exposure index of 200 for a basic exposure of 1/200 second at f/16 in tropical areas. The several factors contributing to this erroneous impression and the correct exposing of film in the tropical and near tropical regions of the earth will be presented in this section.

Measurements taken all over the world of the illumination level of sunlight show that under the same atmospheric conditions and with the sun at the same relative altitude the intensity of daylight in the temperate and tropic regions in general remain approximately the same. The erroneous belief that daylight in the tropics is brighter is a result of the following:

1. Lighting contrast. In tropical regions where very clear atmospheric conditions prevail, lighting contrast is very high. This tends to give the impression to the eye that the intensity is greater than it really is.

2. Subject reflectance. In locations where there are vast areas of coral, white sand, light colored buildings, etc., most of the sunlight is reflected. In this situation the camera's diaphragm must be closed at least one full f/stop. However, in many areas of the tropics the foliage is extremely dense and dark toned, absorbing most of the light. As a result, the camera's diaphragm will often have to be opened from one to three full f/stops above the normal exposure values required for subjects in the temperate zones where considerable foliage also appears.

3. Lighting direction. Lighting in the tropics tends to be strong top lighting, because the sun for a longer period of the day is more nearly directly overhead than in temperate climates. The result is, more supplementary lighting should be provided, than was needed in temperate zones where lower lighting contrast conditions are normally encountered. The objective of the supplementary lighting is to lighten or soften the deep, dark shadows often created whenever the sun is in a position directly overhead and to reduce apparent contrast.

Approximately one-half stop (increase exposure by 50 percent) more exposure should be used than is normally required for average front lighted subjects when photographs are taken during the middle of the day, if additional illumination (supplementary lighting) cannot be utilized.

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